IRON AND STEEL ENGINEER

J. F. KELLY, Editor

CONTENTS

Vol IV. July, 1927 No. VII.

Wm. G. Clyde—President Carnegie Steel Co. II

23rd Annual Convention and Iron and Steel Exposition III

Starting a Steel Mill with the Wave of a Hand V
By Judge Elbert H. Gary.

Taylor Allderdice, President National Tube Co. VII

Plaque Presented to Mr. C. A. Menk by AI&SEE VIII

Pictorial Review of Iron and Steel Exposition 323

An Analysis of the Motor Bearing Problem 329
By Frank W. Cramer.

Discussion: Safe Practices in Connection with the Operation of High Tension Power 332
By Membership.

Electric Locomotive for Hot Mill Service 340
By David J. Munro.

New Sheet Bar and Skelp Mill at Indiana Harbor 342
By A. E. Beardmore.

Blast Furnace Flue Dust and Blast Furnace Control 345
By E. Kieft.

Proposed Revision of Constitution of the Association of Iron and Steel Electrical Engineers 348

(List of Advertisers 328)

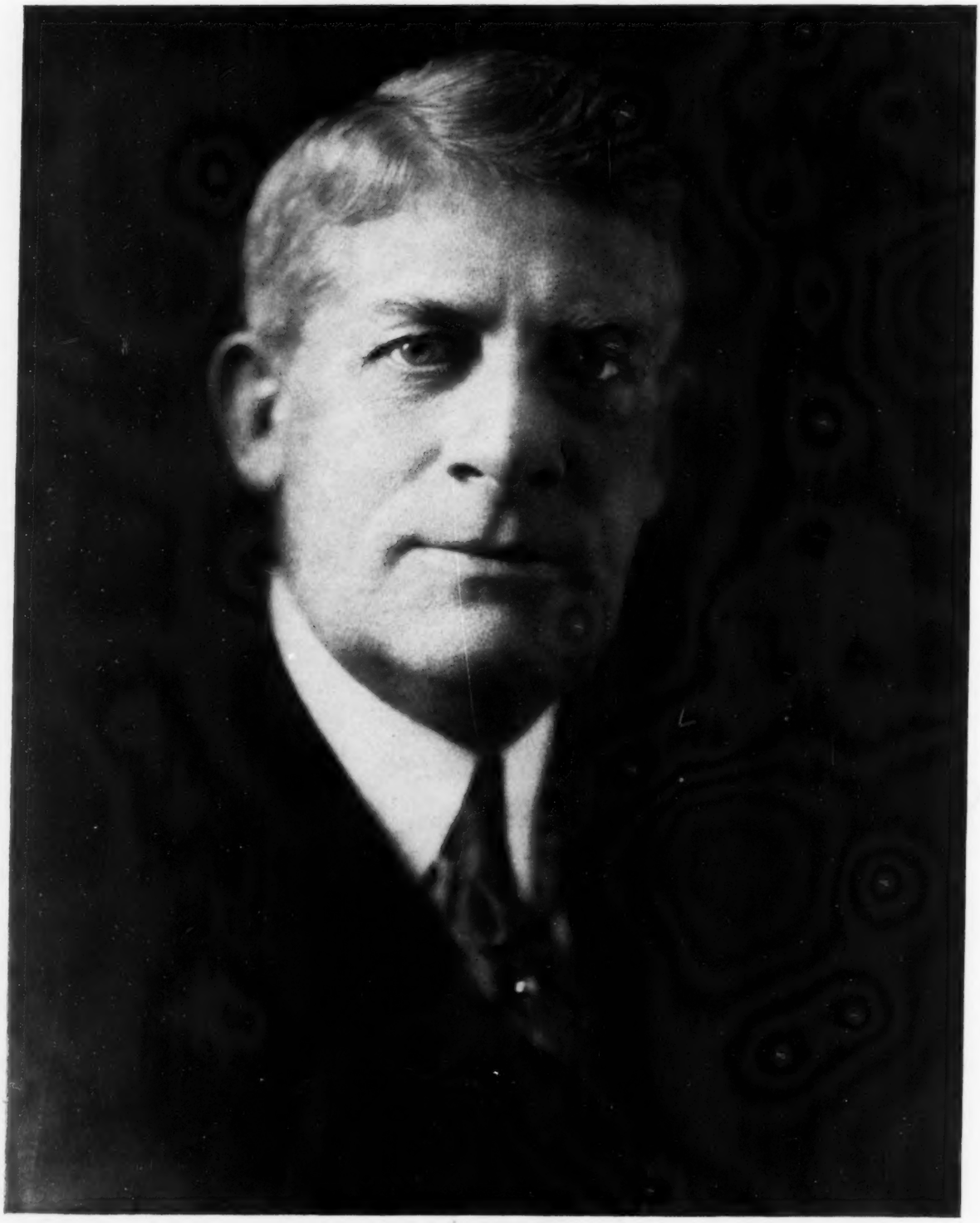
Published Monthly by

Association of Iron and Steel Electrical Engineers

706 Empire Building, Pittsburgh, Pa.

Entered as second-class matter January 25th, 1924, at Pittsburgh, Pa., under the Act of March 3rd, 1879.

Subscription Price $5.00 per Year. Single Copy 50c.



WM. G. CLYDE,

President, Carnegie Steel Company,

who extended the greetings of his company to the Association of Iron and Steel Electrical Engineers on their inspection trip Thursday, June 16th, 1927, to the new structural mills of the Homestead Steel Works, Carnegie Steel Company, Munhall, Pa.

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"Greatest Assemblage of Executives, Engineers, Operating Superintendents and Maintenance Men in the History of the Iron and Steel Industry, at Pittsburgh, Penna., June 13th to to 18th, Inclusive."

Practically twenty thousand persons representing every official capacity in the Iron and Steel Industry attended the Convention and Iron and Steel Exposition, held in Pittsburgh at the Syria Mosque, June 13th to 18th, 1927.

This was by all means the largest gathering of steel mill representatives in the history of the United States.

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On Saturday evening at 10:00 P. M. the Exposition and Convention was formally closed with a bugler blowing the official taps, marking the close of the most successful Convention and Exposition of the A. I. & S. E. E.

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Every visitor at Homestead received a beautiful booklet describing the structural mills at Homestead and Mr. W. G. Clyde, President of the Carnegie Steel Company extended the greetings of his company to the Association.

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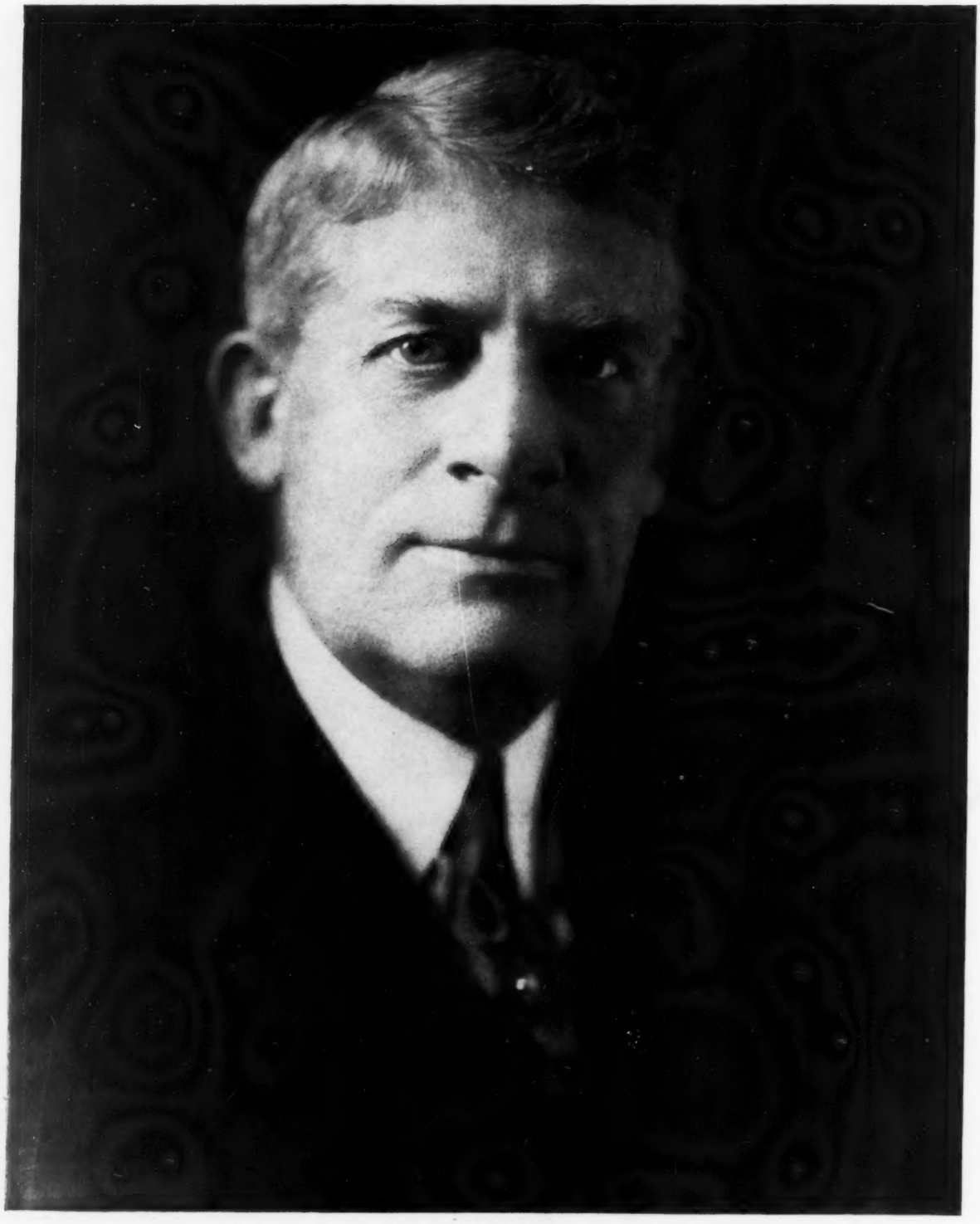

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CARNEGIE STEEL COMPANY
HOMESTEAD STEEL WORKS
JUNE 16, 1927
WELCOME
ASSOCIATION OF IRON & STEEL ELECTRICAL ENGINEERS
A GUIDE WILL CONDUCT YOU AND THE GROUP TO WHICH YOU ARE
ASSIGNED OVER A PLANNED ROUTE WHICH WILL ENABLE YOU TO
SEE EVERYTHING OF INTEREST. PLEASE ASSIST US BY KEEPING
WITH YOUR GROUP, THEREBY AVOIDING CONFUSION.
THERE ARE MANY THINGS TO SEE. KEEP MOVING.
WATCH YOUR STEP. DON'T GET HURT.
SAFETY FIRST, LAST AND ALWAYS.
JOHN S. OURSLER,
GEN'L SUPT.

STARTING A STEEL MILL

With the Wave of a Hand

By JUDGE ELBERT H. GARY

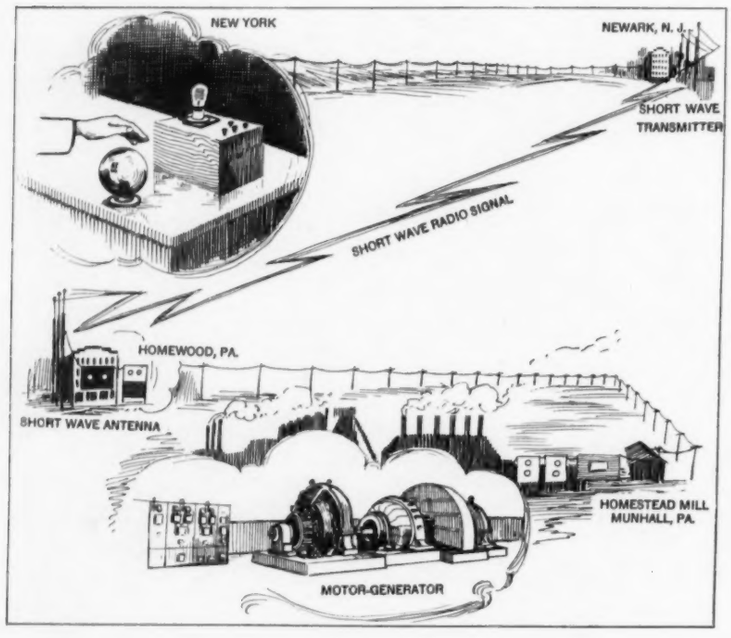
At the Inspection Trip of the Association of Iron and Steel Electrical Engineers to the New Structural Mills of the Carnegie Steel Company, Munhall ,Pa.

MEMBERS AND GUESTS OF THE ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS AWAITING JUDGE GARYS STARTING OF THE 52" CARNEGIE BEAM MILL FROM HIS NEW YORK OFFICE BY WIRELESS 6-16-27.

HOW THE MOTOR WAS STARTED

Radio waves and a supersensitive current-controlling tube were the principals in an astounding feat of remote electrical control, between New York and Pittsburgh on June 16. Seated at his desk in the office of the United States Steel Corporation on Broadway, New York, Judge Elbert H. Gary, chairman of the board, passed his hand over a glass sphere instantly setting in operation the corporation's new Homestead mills, near Pittsburgh.

The demonstration was a revelation of what engineers can do with tiny electric currents in controlling large power machinery. It revealed the adaptability of sensitive electrical instruments as well as an intricate hook-up for the transmission of control signals.



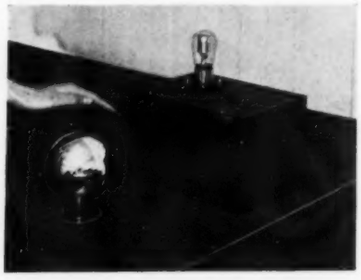
The demonstration was arranged by the Steel Corporation and the Westinghouse Electric and Manufacturing Company as a feature of the Association of Iron and Steel Electrical Engineers' Convention, then in progress. The convention delegates visited the Homestead plant en masse to inspect the electrical installations of the new structural mills and to witness the spectacular start of the motors.

The sphere which rested so inoculously on Judge Gary's desk was lined with silver and in reality served as one plate of a condenser. The hand, passing over the sphere acted for an instant as the other plate of the condenser, releasing a small electrical charge to ground.

The most amazing thing about the operation was the Knowles grid-glow tube to which the sphere was connected. This device is the invention of a Westinghouse engineer and is probably the most sensitive current-controller ever developed for practical use. It is very much like a radio vacuum tube. The tube has a cathode and anode, with a wire grid between. A difference of electrical pressure was set up between cathode and anode by connecting them to a 440-volt circuit. The grid, which normally is insulated from ground, provided the control valve for the tube. A charge accumulates on the grid. So long as the grid is insulated, the charge remains, preventing any flow of current between cathode and anode.

But when Judge Gary blandly waved his hand above the sphere, he provided an outlet for the charge on the grid of the glow tube. The accumulated charge leaped across the gap from the silver lining of the globe, through Judge Gary's body, and thence to ground. In the moment the hand was near the sphere, the tube operated.

The flow of current between the cathode and anode operated a sensitive relay, connected by telegraph line with the Newark works of the Westinghouse Electric and



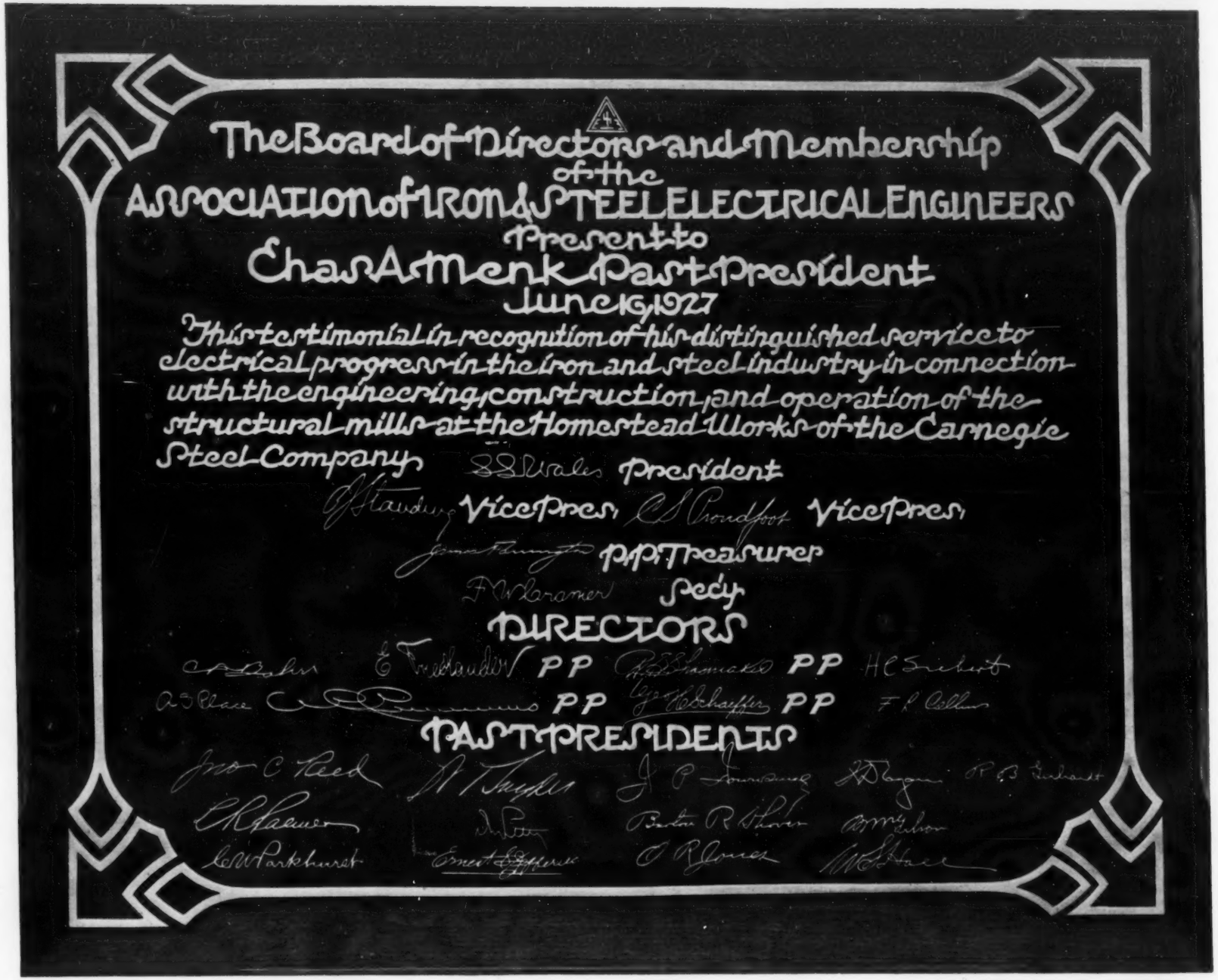
Manufacturing Company. There the signal caused a shift in the frequency of a high power short-wave radio transmitter. The Newark set operates on 42.95 meters, at 20 kilowatts, and is used for interworks communication. A receiving set at the Homewood works of Westinghouse at Pittsburgh was tuned exactly to the Newark frequency, so that the variation of frequency at Newark caused a zero, or "dead" spot during which no current flowed in the receiver.

A line to the Homestead mills transmitted the amplified output of the receiver. The constant current flowing over this line was interrupted by the signal from Newark. The break in the current permitted a gravity selector to operate, which in turn closed a switch setting the steel mill in operation. By changing the setting of the selector, it could have been made to operate either an alternating or direct current motor to start the mill. Actually the flash of Judge Gary's hand started a 6,000 kilowatt motor-generator set which drove a set of large rolls.

The selector was set to operate on three interruptions. These interruptions in turn closed another circuit on the main panel board of the mill, and in a few moments the rolls were turning at full speed.

TAYLOR ALLDERDICE,
President, National Tube Company,
Pittsburgh, Pa.

who was the honor guest at the Safety Engineering Division's luncheon and technical session held in connection with the Association of Iron and Steel Electrical Engineers Convention and Iron and Steel Exposition held June 13th to 18th, 1927, at Pittsburgh, Pa.


The Board of Directors and Membership
of the
ASSOCIATION of IRON & STEEL ELECTRICAL ENGINEERS
Present to
Chas A Menk Past President
June 16, 1927
This testimonial in recognition of his distinguished service to electrical progress in the iron and steel industry in connection with the engineering, construction and operation of the structural mills at the Homestead Works of the Carnegie Steel Company
S S Wales President
Vice Pres.
Vice Pres.
PP Treasurer
Secy
DIRECTORS
PP
PP
PP
PP
PAST PRESIDENTS

PLAQUE GIVEN TO MR. C. A. MENK BY THE AI&SEE

Mr. S. S. Wales, in making the presentation, said in part as follows: "Mr. Menk, who has been the Electrical Engineer in charge of the reconstruction of the Homestead Mills, became connected with the department of which he is now Superintendent about 1891 and rose steadily to his present position.

He identified himself with the Association of Iron and Steel Electrical Engineers, becoming its 11th President in 1918.

We realize that due credit must be given to his able corps of assistants and also all other works departments and executives connected with this great installation, but to us, what we will see this afternoon represents the crowning achievement of Chas. A. Menk, and on behalf of the Association of Iron and Steel Electrical Engineers and the Board of Directors, I have the honor of presenting him with a plaque, in recognition of distinguished service rendered to the Iron and Steel Industry by his able and conscientious work in connection with the engineering, installation and operation of these mills."

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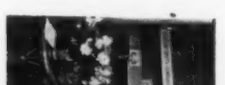

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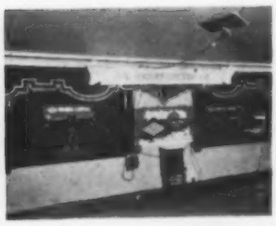
Allegheny Steel Co.

Harold E. Trent

M. H. Detrick Co.

Unishear Co.



Nichols Lintern Co.

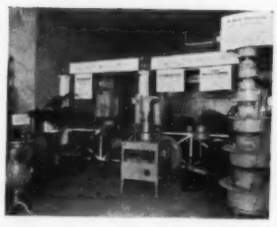
PICTORIAL REVIEW OF IRON & STEEL EXPOSITION

High Lights

Total attendance		23,217
Largest Single Day's attendance on Thursday Inspection Trip to New Structural Mills at Homestead Steel Works of Carnegies Steel Co.	1,020	
Exposition	3,400	
Technical Session	280	
Total		4,700
Best Attended Technical Session on Tuesday		437
Total Tonnage of Exhibits		580 tons
Total booths		203
Judge Gary's starting of one of the large motors at the New Structural Mills at Homestead Steel Works, Munhall, Pa.		
Maintenance Department Employees in attendance at Saturday's Exposition	2,300	
Greatest tonnage of one exhibitor		32,300 lbs.
Lease Weight of one exhibit		15 lbs.

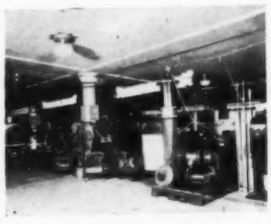
R. D. Nuttall Co.

Keystone Lubricating Co.



Hagan Corporation

V. V. Fittings Co.



General Electric Co.

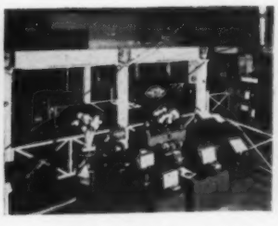
Allis Chalmers Mfg. Co.

Bartlett Hayward Co.

National Carbon Co.

Clark Controller Co.

Electric Service Supplies Company



Crocker Wheeler Electric Mfg. Co.

Norma Hoffmann Bearings Corp.

Ivanhoe Division of Miller Company

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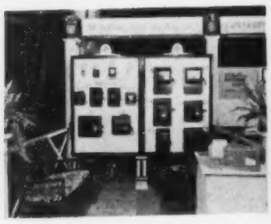
Johns Manville Corp.

Barney Machinery Co.

Timken Roller Bearing Co.

Chicago Fuse Mfg. Co.

The S. Obermayer Co.



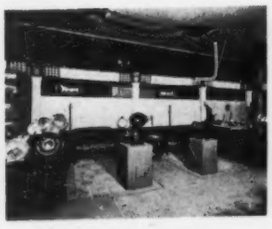
Trumbull Electric Mfg. Company

Tool Steel Gear & Pinion Company

Box Crane & Hoist Co.

National Screw & Mfg. Co.

Bacharach Industrial Instrument Co.

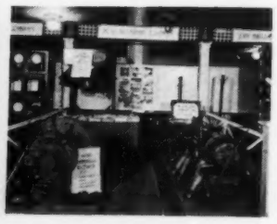


Pyle National Co.

Electric Storage Battery Company

American Brown Boveri Electric Corp.

Carborundum Co.



Rush Machinery Co.

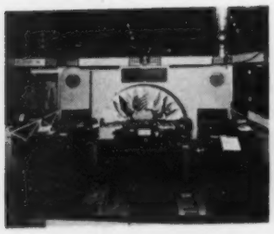
Henry N. Muller Co.

Union Electric Co.

B. F. Perkins & Son

Edison Lamp Works of General Electric

Automatic Reclosing Circuit Breaker Co.



SKF Industries, Inc.

Air Reduction Sales Co.

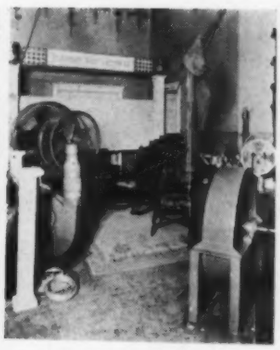
Roller Smith Co.

Wm. Swindell & Brother

Electric League of Pittsburgh

Mesta Machine Co.

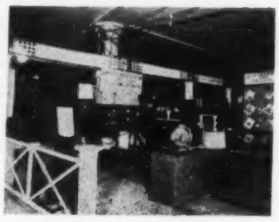
Bussmann Mfg. Co.



Robinson Ventilating Co.

H. J. Saville

Standard Underground Cable Co.

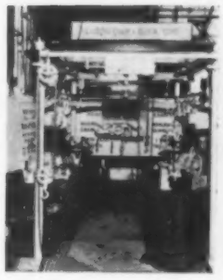


Cutler Hammer Mfg. Co.

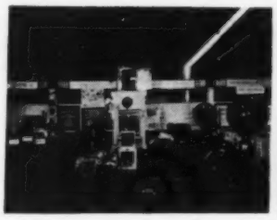
"The Daisy Girl"—Henry N. Muller Co.

Weston Electrical Instrument Corp.

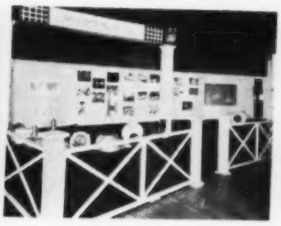
Edwin L. Wiegand Co.



Reading Chain & Block Company



Doubleday Hill Electric Company



Holophane Company

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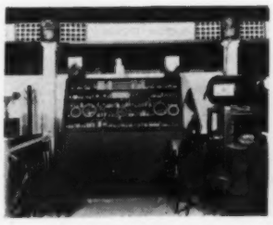

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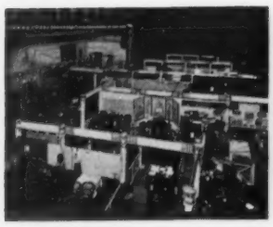
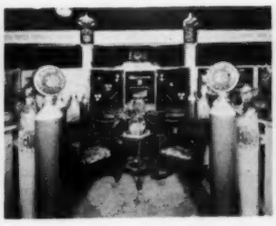


General View—Iron & Steel Exposition

General View—Iron & Steel Exposition

Reliance Electric & Engineering Co.



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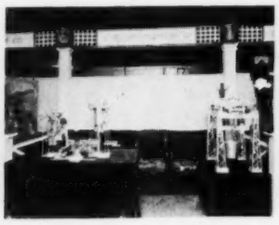

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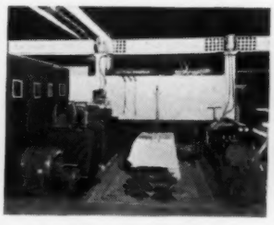

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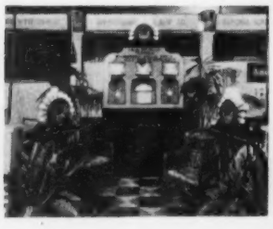

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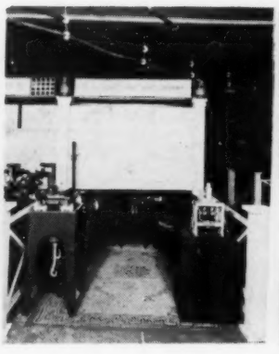

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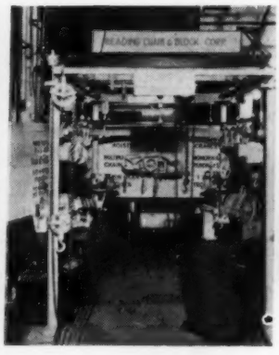

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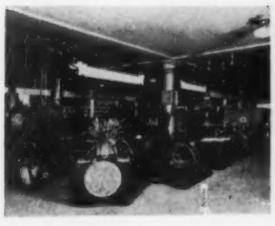

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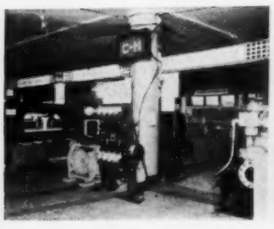

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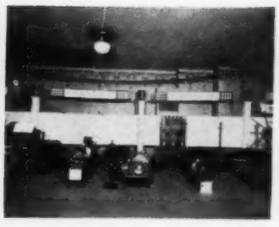

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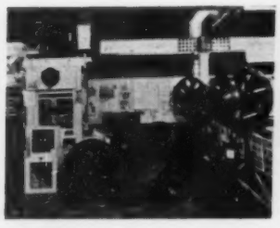

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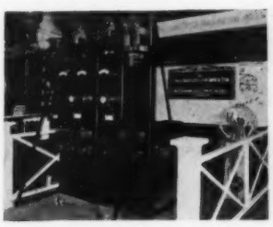

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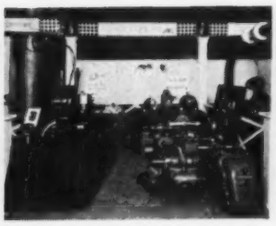

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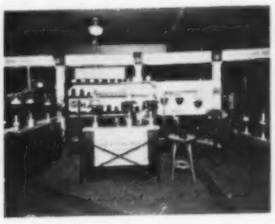

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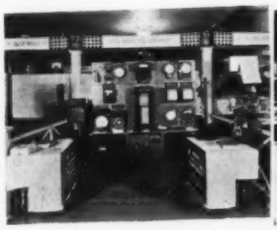

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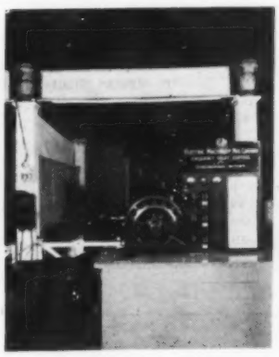

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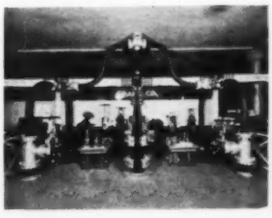

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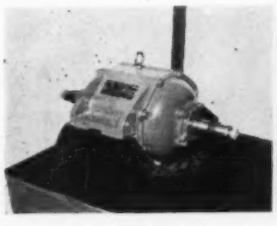
General View—Iron & Steel Exposition



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Morse Chain Co.

Appleton Electric Co.

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Erie Malleable Iron Co.

INDEX TO ADVERTISERS

A

Alliance Machine Company 372
Allis Chalmers Mfg. Company 361
Appleton Electric Company 367

B

Baker Raulang Company 373
Bartlett Hayward Company 389
Boxill Bruel Carbon Company 360
Bussmann Manufacturing Company 396

C

Clark Controller Company 387
Cleveland Crane & Engineering Company 364
Condit Electrical Mfg. Corp. 388
Crocker Wheeler Electric Mfg. Company 365
Crouse Hinds Company ..... Insert
Cutler Hammer Mfg. Company 359
The Cutter Company 385-Cover 3

D

De Laval Steam Turbine Company 377-379
Delta Star Electric Company 378
M. H. Detrick Company 402
Doubleday Hill Electric Company 380

E

Economy Fuse & Mfg. Company 398
Electric Controller & Mfg. Company 393
Electric Power Equipment Corp. 368
Electric Service Supplies Company 363
Eureka Copper Products Company 375

F

Fafnir Bearing Company 390
Farrel Foundry & Machine Company 384
Fawcus Machine Company ..... Cover 1

G

General Electric Company ..... Cover 4
Graybar Electric Company 377

H

Hullhorst Micro Tool Company 400
Hyatt Roller Bearing Company 383

I

Iron City Electric Company 375

J

Johns Manville Corp. 394

K

Keystone Lubricating Company 391
Kuhlman Electric Company 399

M

Martindale Electric Company 379
Moloney Electric Company 373
Morgan Construction Company 374
Morgan Engineering Company 386B
Morganite Brush Company 370

N

National Carbon Company 355
Nichols Lintern Company 358
Norma Hoffmann Bearings Corp. 386
R. D. Nuttall Company 401

O

Ohio Electric & Controller Co. 356

P

Pittsburgh Transformer Company 378
Pyle National Company 376

R

Reliance Electric & Engineering Co. 352
Roller Smith Company 381
Rowan Controller Company 371
Rumsey Electric Company 376

S

Shepard Electric Crane & Hoist Co. 366
SKF Industries, Inc. 395
Smith & Serrell 372
Stackpole Carbon Company 382
Standard Underground Cable Co. 381

T

Timken Roller Bearing Company 392
Thompson Electric Company 380
Tool Steel Gear & Pinion Co. 397
Trumbull Electric & Mfg. Company 369

U

United States Graphite Co. 371

V

V. V. Fittings Company 362

W

Westinghouse Electric & Mfg. Company 354-357-370-Cover 2
Weston Electrical Instrument Corp. 374
Edwin L. Wiegand Company 353

An Analysis of the Motor Bearing Problem*

By FRANK W. CRAMER†

IN a paper delivered before this association in 1921, Mr. A. M. McCutcheon, of the Reliance Electric & Engineering Company, called attention to the various advantages and disadvantages that could be expected in the adoption of anti-friction bearings in steel mill motors, and in his analysis raised the question whether or not this type of bearing possessed sufficient merit to warrant a thorough trial under operating conditions. After a lengthy discussion of the anti-friction types of bearings, the author, in his conclusion, suggested that the steel mill electrical engineers evolve a plan to carry on further experimental work with ball and roller bearings, and report their results to the association.

Late in 1922, Mr. L. J. Hess, of the Youngstown Sheet & Tube Co., presented a paper on "Roller Bearings Applied to Mill Motors" that set forth the various experiments and results that were obtained by the author in changing sleeve bearings in existing mill motors to anti-friction bearings. In his conclusion, the author felt that the mill type motor, with babbit bearings, would be soon supplanted by roller bearings; for it had been proven to his entire satisfaction that by careful designing, they could be applied to practically any motor at a saving that would soon repay the extra initial cost.

In September of this same year, Mr. D. M. Petty, Chairman of the Standardization Sub-Committee on motors, presented a report at the annual convention which included the replies obtained through a questionnaire on "The Use of Anti-Friction Bearings." The results from this questionnaire indicated, and the committee recommended, that it was imperative for bearing manufacturers and motor manufacturers to line up standard anti-friction bearings that would be interchangeable from one line of motors to another.

Perhaps the outstanding feature of this report was the fact that when the answers to the question on "Breakdown Due to Insulation Failures Due to Oil" were compiled, it was found that 37% of all A.C. motor failures, and 41% of all D.C. motor failures were attributed to this source. The accuracy of these figures has never been questioned, as they are the average of records of the Electrical Engineers in the twenty-five largest steel plants in this country. However, in justice to sleeve bearing designers, it can be pointed out that these totals included all motors then in service whether manufactured in 1890 or in 1922.

The intention of the committee was to secure the percentage of motor failures due to various causes. Now if their desire had been to show the progress of sleeve bearing design over the past thirty years, it could have been shown that motor failures caused by sleeve bearing troubles would have been far less in the modern mill type motors than failures from similar causes in the old railway type motors.

Another fact that should be brought to your attention is that this high percentage of failures cannot be attributed entirely to sleeve-bearing design. It is a well known fact that oilers in steel mills have a habit of giving the motors plenty of oil, and much of that found in the windings of the older type motors, unprovided with overflow pipes in the housings, comes direct from the oil-can rather than from the bearings. It seems that trouble of this nature arises more from excessive oiling of the motors than from lack of oiling. It should also be pointed out that while oil does tend to soften some kinds of insulating varnish, and may in some cases, be the cause of insulation failure, this cause is not as serious as some people are inclined to believe.

It is common practice for transformer coils, compensator windings, and oil immersed contactors to have their insulation submerged in oil, which does not attack the insulating varnishes.

Unfortunately, the misinterpretation of these tabulations from the questionnaire aroused an undeserved prejudice against modern sleeve bearings, which fact will be discussed later on.

Soon after this report was written, the "Special Bearings Committee" held a series of meetings with representatives of various manufacturers of ball and roller bearings that finally resulted in the adoption of a standard series of dimensions for general purpose motors, so that both ball and roller bearings would be interchangeable so far as inside and outside diameters were concerned.

Since the adoption of these standards, a great many valuable and informative papers have been presented before this Association on anti-friction bearings which have shown the wonderful progress this type of bearing has made during the past five years; and also results of research work regarding the probable life of their operation.

During all this period of progress and development of anti-friction bearings a search of the Association papers reveals that for some unknown reason, no engineer has presented a single article on sleeve bearings. Perhaps, as one suggested, "Familiarity breeds contempt, and in many cases the sleeve bearings have been the victim." "They have been blamed for the results of abuse they have suffered; they have been denied suitable protection in the presence of destructive elements; and while new competitive types of bearings have been loudly heralded, their homely virtues have been largely unextolled."

Before discussing some of the virtues of sleeve bearings, and improvements in their design, another paper presented before this Association, in 1920, by Mr. T. D. Lynch, a Research Engineer of the Westinghouse Co., should be referred to. This paper deals with babbits and babbiting; and is followed with the able discussion of Dr. J. S. Unger on the same subject. The necessity of proper mixes and treatment of bearing materials is very forcibly brought out in these articles. This paper, if carefully read, will show that many thousands of the sleeve bearings included in the "Questionnaire Result" could hardly be classed as A-1 bearings, and

*Present at Annual Convention Pittsburgh, Pa., June 14, 1927.

†Asst. Supt., Elec. Dept., Bethlehem Steel Co., Johnstown, Pa.

results of their operation should not be compared with precision made factory anti-friction bearings.

One of the advantages of sleeve bearings is that in case of necessity, a mill mechanic can manufacture a new one, or in the general run of work, a worn bearing can be re-babbited and made ready for service again. The ease and low cost with which this can be done causes a lot of mechanics to overlook the importance of methods and materials as emphasized in Mr. Lynch's paper. The use of re-melted and perhaps worn-out babbitt; the wrong proportion of materials melted down at a temperature that pleases the melter without any thought of the proper temperature; the failure to properly clean the shell; the boring out on an ancient lathe rescued from the scrap pile; one or all of these operations may have resulted in what was called a sleeve bearing. There are thousands of bearings of this type in operation today whose performance is being compared with high class precision-made anti-friction bearings.

It is true that in our industry, the smaller plants especially are not equipped with chemists and metallurgists who can supply the Purchasing Agent with specifications for babbit-metal; or if they do supply the specifications, they do not test and analyze the purchased material to see whether it meets with their specifications. It is also true that even though first class material is purchased, some plants do not have the equipment to control temperatures and properly make a first class sleeve bearing. But, with all these conditions against them, the mill mechanics often turn out sleeve bearings that will fit in the motors and machines, and which when the cost, materials available, and method of manufacture are considered, give wonderful results.

Then it may be that this home-made bearing is not given a fair chance after it is installed. There are thousands of motor installations in this country where flexible couplings and proper mountings would accomplish wonderful reductions in bearing costs. Vibration that is transmitted to the armature shaft pounding the bearings twenty-four hours a day will shorten bearing life. It will also have greater effect in throwing the oil from the bearing housings into the armature. On the other hand, anti-friction bearings are usually installed on modern installations, where end thrust and proper alignment have been given some consideration, and the design is such that excessive vibrations are not transmitted to the motor.

It should also be noted that anti-friction bearings will stand more vibrations and hammer blows than a babbitt bearing because steel will not flow under the same pressures that will rapidly destroy a babbitt bearing. This is well illustrated by the many installations of both ball and roller bearings in old motors to avoid frequent changing of bearings and armatures.

These few remarks about actual operating conditions are written to show that sleeve bearings collectively, both in mill manufacture and maintenance, do not make a fair comparison with the factory made precision anti-friction bearing. But from an operating standpoint, their simple construction and ease of fabrication, by the average mechanic, are a form of insurance against long delays when one fails and a spare is not at hand; and also enable mills to carry a comparatively low inventory of bearings and bearing material.

Now, if we look into the high class precision-made sleeve bearing, such as turned out and furnished by the manufacturers, a different light is thrown on the subject. Long ago, their research engineers found out that the proper mixing of materials, and use of different mixes for different classes of work were essential to good sleeve bearings, also that this mix has to be properly handled during melting; that the shell has to be properly prepared; and many other precautions have to be taken so that their bearings are made right. Then too, they realized that mill oilers never look at oil gauges, so they designed overflow pipes that would allow excess oil to run out of the bearings faster than the oiler could pour it in. They thus eliminated this defect. They also found that they could design a housing that would prevent the lubricant from getting outside the bearing, and prevent the outside dirt from getting inside. When all this was realized, modern sleeve bearings were ready for the market, and they can be purchased today with a guarantee of running at least a year without additional lubrication.

During the past few years, we have heard a lot about saving in friction loss of the roller and ball bearings over the sleeve type. Some of the data on these tests was secured by equipping similar motors with the different types of bearings, and after accelerating them to a given speed, shutting off the power and letting them drift to a stop. All these tests showed that the motors with the anti-friction bearings would drift longer than those with sleeve bearings when the initial speeds were under 600 RPM; but on the higher speeds, the advantage was diminished. In fact, some tests with motor speeds between 1200 and 2000 RPM did not give either type the advantage. But motors are usually installed to drive machinery, and if similar tests were run with operating loads mechanically connected, it is doubtful if any difference would be found. Another way of stating this is that the total friction of both motor and driven load is many times the motor friction, and a small saving that may be possible in motor bearing friction would not materially reduce the total friction load even on the slow speeds.

The real advantage of the ball or roller types of bearings, over the sleeve bearings, is in the starting friction which, in case of the former, is practically the same as the running friction. In the sleeve bearings, the starting friction is comparatively high, but drops off rapidly as the shaft begins to rotate, and the oil film is established. This unfavorable comparison of starting frictions should not be assumed to apply to running conditions.

Another of the often discussed points is life of the bearings. All commercial bearings consist essentially of three parts, a rotating part, a stationary part, and a separating medium. In the sleeve bearing, oil is the separating medium, and in the anti-friction type, the balls or rollers, with some addition of oil or grease, represent that medium. Now, so long as the film of oil is maintained in the sleeve bearing, there can be no wear or deterioration in the bearing or journal, and under such conditions its life would be infinitely long. On the ball and roller bearings, the parts are in metal contact and are sub-

ject to repeated stresses which bring into operation the laws of fatigue of metals. These laws teach us that metals subjected to repeated stresses eventually break down after a given number of repetitions of the stress, hence ball and roller bearings do have certain limitations to useful life. The manufacturers of this class of bearings recognize this fact, and recommend a very conservative load rating in order that the life of a bearing be extended. One of the authors in the February issue of the Iron and Steel Engineer stated that the preliminary report of the Standardization Committee expected that this life would be 40,000 hours.

Examples of sleeve bearings can be found that have given thirty or more years of service; perhaps the same can be said of anti-friction bearings, so that under ideal conditions either type of bearing should outlast the machine.

Certain other comparisons of factors, that in actual operation affect the life of bearings, could also be made. One of these is heat. In the sleeve bearing, the oil passing back to the oil well carries heat away from the point of generation, while balls cannot escape from the bearing for cooling, which must take place by conduction through the steel of the races to the housing and shaft. We also know that brass sleeve bearings will stand high temperatures, but the babbitt bearings must be kept much cooler than the maximum allowable temperatures on anti-friction bearings, due to the low melting point of babbitt.

Another comparison often made is on maintenance costs particularly of oiling. Now, it is a claim for the anti-friction bearings that they need be oiled or greased only once a year. It is also claimed and proven that modern sleeve bearings will operate a similar period without additional lubrication. When a fair comparison is made on oiling costs, it appears that neither type of bearing has any great advantage so far as oil or grease leakage is concerned. There is just as much likelihood of an excess of grease in anti-friction bearings as there is oil in modern sealed sleeve bearings. In a recent installation, containing over 200 mill type motors with modern sealed sleeve bearings, there has been not one bearing failure or armature failure, due to oil, in eighteen months of operation.

Another item should be interesting in an analysis such as this; that is the item of spare equipment which determines the inventory account. Sleeve bearings can be fitted on an armature, and little care need be taken with its storage until needed. It is doubtful if the anti-friction type would operate if neglected in some millwright's shanty with no particular attention paid to keeping them dry or filled with grease.

As stated before, most any inspector or mechanic can scrape a sleeve bearing and get a fit. In case of breakdown, and no spare anti-friction bearings on the new armature shaft, could they fit the old bearings on the new armature in the field, or would it be a shop job? To make it a field job, what tools and equipment would have to be carried in each repair district?

Another item worth consideration is the actual increase in the inventory account if anti-friction bearings have to be purchased for the spare armatures over sleeve bearings for the same purpose. With this should be considered extra precautions required in the storeroom to keep these bearings in first class condition until they are needed.

An analysis such as this, digesting claims and counter-claims for both the sleeve and anti-friction bearings, makes it logical to conclude that there are, on the market, first class bearings of both types that motor manufacturers are willing to install on any general purpose motor. In special cases, for slow speeds, and where starting friction is the controlling factor, the anti-friction bearings may show up to an advantage, but in other installations, such as turbo generators, where in extreme cases the bearings must support a weight of one million pounds, the sleeve bearing, with oil under pressure, has an advantage.

At the present time, we can venture that about 20% of steel mill bearing users are ardent advocates of anti-friction bearings for most every installation. We can also venture that there is another 20% who insist on sleeve bearings for all installations, and we have left about 60% who represent the majority, and these insist on the type of bearing that gives least trouble and lowest maintenance cost.

As a result of this condition, we find that all the large motor manufacturers are forced to carry tools, patterns, castings, etc., to equip their motors with either type of bearing. An example of this can be found in the new G. E. motor that is built to the A. I. & S. E. E. standards, where the overall length of the motor could be shortened, and wasted space in housing eliminated, if it were certain all the customers would ask for anti-friction bearings. This condition naturally means a larger investment for the manufacturer, which must be reflected in his selling price. It seems logical that we, as an Association, could take some steps towards solving this problem, and perhaps suggest that certain types of motors, for given applications, be built only in sleeve bearings, while certain other types be furnished only with anti-friction bearings, and perhaps some few types be designed to take either kind of bearings. What we, as individuals, think and write on this subject will have little bearing on the solution of this problem.

Maintenance costs and continuity of service of the types will be the deciding factor. It will not be a question of one bearing operating thirty years, but how many of each type in thousands of installations fail the first year, the second year, etc., from all causes collectively. Calculations and prophecies never replaced the steam engines with motors. It was the fact that after the motors were installed, they proved the claim and calculations, and showed actual savings in operating costs.

Now, if we can assemble sufficient data on life, cost, and service on anti-friction bearings, and compare it with similar data secured from modern precision manufactured sleeve bearings, we perhaps could make definite recommendations for each type on different classes of motors.

Or perhaps it would be determined that neither type represented the perfect motor bearing, and the designers would be able to develop a new type that would fulfill all conditions. When this is determined, the bearing problem will be closer to solution.

DISCUSSION

A. J. Brown:* There is a great deal of truth in Mr. Cramer's statements, that the virtues of the sleeve bearing have been generally ignored, while those of the anti-friction bearings have received a great deal of attention. It may be that because the sleeve bearing has been in use for so many years and established such a lasting reputation that it needs no defense. The sleeve bearing is a long way from being discarded and in fact has a very bright future, as it is still subject to considerable improvement. It is difficult to find an important machine part that has been abused in design, manufacture and operation, as much as the sleeve bearing and still give such reliable service.

In general, the pedestal type of sleeve bearing has proven very reliable. There are any number of cases where pedestal bearings have run for many years without noticeable wear and in some cases, even the oil is not changed over two year periods. Of course in cases of severe vibration and pounding, the record isn't so good, especially if the design was faulty. But on modern steel mill pedestal bearings, that have been designed to withstand severe thrust and pounding, I believe the record has been very satisfactory.

However, on the housing type of sleeve bearing, the story has been quite different and I believe this is the type of bearing that Mr. Cramer's paper pertains to. On this type, the earlier designs were far from being perfect. Often, little attention was paid to proper proportions, so that the bearing could carry equal loads over its entire length and frequently it had no chance to equalize its load due to inaccuracies in machining and assembly. Also, little attention was paid to expansion and not very much to lubrication, as the oil wells were small and the oil grooves were poorly arranged, usually with sharp edges which made excellent scrapers. Oil baffles, if supplied at all, were of little value.

But the latest designs of sleeve bearing motors, show marked improvement in these various details. When the sleeve bearing receives as much care in design, manufacture and operation as the anti-friction bearing, it can be made to give surprising results. This is borne out by what is being done with steam turbine bearings, where pressures run up to 150 lbs per square inch and velocities up to 8500 ft. per minute. For high speed work as well as for many other applications, the sleeve bearing will continue to be of great value.

There are many places, however, where the anti-friction bearing has distinct advantages over the sleeve bearing. The anti-friction bearings are usually accurately made but not always properly applied. There have been mis-applications in the type of bearing as well as improper size and mounting. When proper attention has been paid to the service involved in an application, it is not so difficult to pick out a type and size, as well as provide suitable mountings, which will give a very reliable bearing. It is necessary to consider the amount of vibration and shocks to be encountered, as well as end thrust and variation in temperature. Temperature governs the kind of lubricant as well as affects the expansion of parts.

The anti-friction bearing, especially of the roller type, when properly applied, makes a very rugged motor bearing that will stand considerable abuse. Its design makes it fairly fool-proof in operation, as it requires little attention and because it has practically no clearance nor wear, makes a very desirable bearing for induction motors where the air gaps are so small. It is also suitable for high temperatures that would cause trouble in a sleeve bearing, as it does not depend upon an oil film for lubrication. Likewise in extremely low temperatures, where the sleeve bearing depends upon a certain amount of generated heat, to maintain an oil film, the anti-friction bearing will operate without difficulty.

In regard to repairs or replacements, the sleeve bearing undoubtedly has an advantage over the anti-friction bearing, as much less time and equipment is required. In the matter of deterioration of spare parts; the sleeve bearing has the advantage.

The practice of protecting the anti-friction bearing with a flexible coupling, as mentioned by Mr. Cramer, is also good protection for the sleeve bearing and is a step in the right direction, as it protects the motor as well as the bearing.

The field of bearing application is big enough so that there is room for both types of bearings and I believe that the sleeve bearing will continue to hold its friends in many lines and that the anti-friction bearing will gain many friends in other lines. In the middle ground where either type is satisfactory, it will be a case of the survival of the fittest.

*Mechanical Engineer, Electrical Department, Allis-Chalmers Mfg. Company, Milwaukee, Wis.

Discussion: Safe Practices in Connection with the Operation of High Tension Power

By MEMBERSHIP

F. D. Egan*: The commendable work of the safety committee as presented by Messrs. Cartwright, Hughes and Gramm in their treatise covering, "Safe Practices in the Operation of High Tension Power," prompts me to offer a few ideas along the same line that have been put into practice at the Lackawanna Plant of the Bethlehem Steel Company to insure safety for employees working with or near electric power of any voltage.

About 90% of the total electric power used at Lackawanna is purchased from the Niagara, Lockport & Ontario Power Co at 60,000 volts It is then

*Supt. Elec. Dept., Bethlehem Steel Co., Lackawanna Plant.

stepped down through two banks of transformers 15,000 KVA capacity each, to 6600 volts and also through a 6000 KVA capacity bank to 2200 volts. Power is transmitted overhead through the plant on steel towers by means of a loop system of transmission, looping into switching stations and paralleling on the bus with a 12,500 and a 7,500 KW steam turbine driven generating units at 6600 volts.

Power is delivered to nine (9) electric mill drives at 6600 volts, but is stepped down to 440 or 220 volts for A.C. and 250 volts for D.C. auxiliary motors. The 220 volt A.C. has been substituted in place of 440 volts on all new installations. Inasmuch as statistics show that 10 out of 12 fatalities from electric shock at the Lackawanna Plant during the past 12 years occurred on 440 volt circuits. It would seem that employees working in the vicinity of that voltage do not recognize its potency, and therefore, fail to exercise a degree of caution in conformity with the danger present.

The record of fatalities revealed also that only one (1) man out of twelve (12) electrocuted, was an employee of the Electrical Dept, which inaugurated a campaign of advertising, in order to educate non-electrical men to be cautious when working near electric circuits.

All exposed circuits and bus bars are posted with signs plainly visible indicating the voltage of the circuit. High tension oil switches are placed in modern concrete cell compartments with wooden cell doors made to cover the three cells of one circuit, thereby eliminating confusion and opening of wrong disconnect switches when switching. The line number and voltage of the circuit is placed on a sign suspended across the cell doors.

In order to bring home more clearly to each individual operator, lineman and electrician, the importance of "Safety First" when handling power circuits, we have issued in bulletin form a symposium of safety instructions, which is patterned after a similar code compiled by the Niagara, Lockport & Ontario Power Co.

Each man working in the power organization is furnished a copy of the instructions and signifies his understanding of the subject matter contained, as well as his intention of complying with them by signing his name on the statement attached, and returning same to his respective foreman, who in turn puts it on record file

The following is a reproduction of the first bulletin issued on safety instructions covering, "Switching Instructions for Station Attendants." A second and third bulletin of instructions have been issued to cover motor generator starting and "power interruptions." We regret, however, not having sufficient space to include a lengthy reproduction of them in this article

SAFETY FIRST SWITCHING INSTRUCTIONS No. 1

Instructions for Station Attendants

1. Oil switches on incoming transmission are never to be opened except on orders from Power Department. Always find out name of person giving the order and find out why and write it in the log book. Power may be passing through your oil switches although your station is entirely down.

2. The Power Department will provide you with a sign wide enough to cover the three phases of a circuit with the following sign:

DO NOT OPEN—Unless Ordered by Power Dept. which you will be held responsible to see that this sign is always kept in the proper place over the three disconnecting switches belonging to its respective circuit. Any work being done on the line this sign shall be covered by a sign of same width with notation:

DANGER 6600 VOLT—Leave This Switch Out.

3. Always be sure that you are pulling the disconnect switches for the same oil switch you have opened. Opening a disconnecting switch on either side of the three which you have cleared by opening the oil switch may mean the interruption of large amount of power and may also mean the loss of your eyesight. You have only ONE PAIR OF EYES and you better PROTECT THEM.

4. No disconnecting switch is to be pulled before checking that oil switch connected either in front or back of this switch is open. This means that not only is the oil switch control switch to indicate "green" but that lever on top of oil switch is to be checked for open position.

5. All switching inside a station will be done only by that operator. The repairman when satisfied that switch and disconnects are opened must fasten tag and lock on switch handle and switch handle must not be closed until tag and lock is removed by repairman. The form tag used gives the repairman's name, check numbers, date, where work is being done and approximate time work will be finished.

6. Extreme care should be taken that all three disconnecting switches of a circuit are opened if one is opened and that all three disconnecting switches are again closed before oil switch is thrown in, in case you have occasion to open any circuit. When you are sure you are ready to close a disconnect switch close it home. Do not feel for a circuit with your knife blade. If the circuit is in trouble better have the oil switch trip out than to have the arc in the air in front of you.

7. In case any work is to be done on either 440 volts, 2200 volts or 6600 volts, rubber gloves with leather gloves over them are to be worn at all times.

8. Care should be taken that any portion of the body may not come within one foot of any live 6600 volt circuit. In working around disconnecting switches do not depend on any old wooden box covering up these switches. Some nail you didn't see may bring 6600 volts through you. Use a properly formed high voltage rubber matting in addition to any other barrier you have and wear your gloves. Keep your knees out of the cells.

9. If it is necessary to work on your MG sets or transformers disconnecting switches are provided for clearing this equipment from the bus.

10. Always remember a transformer backs up as well as steps down. Although you may have opened your oil switch on the high side you may still have 6600 or 440 volts on your transformer from the back feed. Always clear both sides of a transformer before working on it. Motor generator sets may also back up through the D.C. end in case of failure of A.C. running switch to trip out.

11. When working on a current transformer for meters or relays always short circuit the secondary

before opening the meter or relay contacts. Never open the secondary of a current transformer as it has a very high voltage kick and you may be burned severely.

12. Check your ammeters, wattmeters and watt-hour meters daily to see that they are functioning properly and become familiar with what loads you may expect. Anything abnormal is an indication something is in trouble and should be immediately reported to Electrical Supt. Office.

13. Any relays not functioned properly should be reported and stated on load and every interruption of power should be logged carefully, giving time "off" and "on" with any information concerning the trouble that you may know about.

14. After switches are pulled and repairman has made sure the lines are dead, he must short circuit all three phases with grounding lead and insulating stick provided for this purpose. This ground lead must be removed by repairman when work is complete.

15. After work is finished repairman must notify operator that line is clear and circuit can be closed, remove his tag and lock, tag to be kept by operator for file record, and record made in log covering the cause and all information available concerning work done.

16. Remember that your life as well as the life of your fellow worker is always in danger when switching high tension voltages. If in doubt get clearance from someone who knows.

YOU CAN NOT BE TOO CAREFUL.

Date.....

I have received and thoroughly understand switching instructions No. 1 of Bethlehem Steel Company, which I will observe during my employment by this company.

Signature..... Symbol..... Check No.....

..... Operator, Station.....

nature of the job, and "set up" conditions. Before starting the repair job, an instruction sheet is worked out by the Power and Line foreman in co-operation with Electrical Superintendent's Office stating the procedure to follow, as well as switches to open in order to sectionalize and kill the line to be repaired.

The following is a copy of the work sheet worked out to cover switching for a repair job.

SWITCHING INSTRUCTIONS

For Installing New Disconnects on P26 and P29 Lines April 3rd, 1927

Power Station will order out oil switches and disconnects on P26 and P29 after No. 14 Mill rolls out.

No. 2 Power Station will order out oil switches and disconnects on D29 and N26, also disconnects on 29X. Repairman will test 26 and 29 lines with voltage detector before putting ground on same.

When work is complete, repairman will notify No. 2 Power Station that lines are clear and ready for power.

No. 2 Power Station will order in disconnects and oil switches on D-29, N-26, P-26 and P-29.

When the repair work has been completed and the circuit restored to normal operation with power on all lines, the foreman in charge carefully logs the sequence of operations in the following form, giving accurately time of opening and closing switches, as well as other details of switching. This form is attached to a copy of the switching instructions issued for the job and placed on reference file.

To simplify the work, every switching station in the system is designated by a letter of the alphabet and every oil switch bears the number of the line on which it functions. The continuation of a line bears the same number throughout the plant, but prefixing the letter of a station to the number of the line definitely locates the switch under consideration and eliminates possibility of confusion in switching. The number of the oil switch is stenciled on the control

BETHLEHEM STEEL CO—LACKAWANNA PLANT
ELECTRIC POWER DEPT.

MEN WORKING ON LINES

Year, **1927** Month, **April 3** This Record made by **J. Tonks** Symbol and No., **DE-14** Power Sta., **No. 2**

Date	M. U. at Switches	Sta. or Mill	Time Marked Up	Marked up For	Marked up by Operator	Marked Clear By	Time	Time Cut In	Operator
							P. M.	P. M.	
	P-26	#14 Mill	3:58 A. M.	F. Burgardt	Siefried	Burgardt	3:40	4:08	G. Davidson
	P-29	#14 Mill	3:58 A. M.	"	"	"	"	4:08	G. Davidson
	D-29	#3 Sub-Sta.	7:25 A. M.	"	Leonard	"	"	4:05	J. Wozinski
	N-26	#12 Mill	7:30 A. M.	"	G. Davidson	"	"	4:14	G. Davidson
	29-X	#12 Sub-sta.	7:00 A. M.	"	"	"	"	Left open	O. K.

Probably the most dangerous electrical work at the Lackawanna Plant is overhead high tension transmission line maintenance, although our loop system of transmission permits isolating and killing any section of the system for repair work without interrupting the continuity of service to the mills. No repair work is done while the lines are hot.

To further minimize hazard, the power and line repair gang are made thoroughly familiar with the

panel. A mark up board of transmission lines and oil switches is placed in the Power Station and a duplicate board in the Electric Superintendent's Office that show at all times the "set up" of switches.

All switching is carried out under the personal supervision of the power foreman to eliminate confusion, and a safety tag bearing check number of men working on line is placed on the switches at each end of the circuit. This tag indicates that

DO NOT CLOSE

CIRCUIT .....DATE.....
ORDERED OFF BY.....TIME.....
ORDERED ON BY.....TIME.....
REASON: .....
....
OPERATOR .....SUB-STATION No.....

When removed from Circuit Mail to Load Dispatcher
2093-3m-2.26-B. S.Co. **Bethlehem Steel Company**

CAUTION

CIRCUIT .....
ORDERED OFF BY.....
TIME .....
REASON: .....
....

Hold in Sight for Relief Operator
Bethlehem Steel Company

switch is not to be closed until line is cleared of men working by repairman in charge personally removing his safety tag. The inserted tag is a sample of the tag used.

After the line to be repaired is cut out, the power foreman checks for voltage between phases and voltage to ground by means of a Sweitzer-Conrad type AT, "High Voltage Detector." If line shows no voltage, all phases are solidly shortened and grounded, each side of the section to be repaired by means of grounding sticks provided for the purpose. These ground sticks consist of a 6' long hard wood seasoned pole, on one end of which is a copper clamp which is hooked over the line cable and securely clamped in position by turning the wood handle. The copper clamp is connected through a flexible copper cable to another clamp used to connect to ground. To put a ground stick on a line the ground clamp is first solidly connected to ground, then the cable clamp is hooked over the cable by means of the long wooden pole and screwed tight on the line, completing circuit through flexible copper cable from line to ground. When all phases of the line each side of the section to be repaired are connected to ground in this manner, the workmen are protected from line discharge as well as induced voltage from an adjacent circuit carrying A.C. load. After the line is securely grounded, the power foreman reports to line foreman that the line is clear for repairmen to go aloft and make repairs. Ground sticks are being used very satisfactorily by us.

We also find the high tension voltage detector a very practical accessory to switching equipment, as it may be used to determine phase relation of two circuits that have a common source when paralleling in a common bus remote from the source of power, as well as indicating the presence or absence of voltage on a circuit.

Repairmen and station attendants are furnished with heavy rubber gloves, sheathed in leather protectors, to be used whenever doing any high tension switching, as well as rubber blankets and rubber sheaths to slip over bare conductors on adjacent circuits. Wooden safety platforms mounted on insulators are provided in stations where switching takes place on outdoor structures.

The hazards in connection with low voltage circuits are being reduced by replacing open type knife switches with quick break enclosed safety switches.

Open wiring of feeds for auxiliary motors is rapidly being replaced with concealed conduit. All open bus is protected by screening with wire grill work.

Inasmuch as there has been but one (1) fatality from electric shock at the Lackawanna Plant during the past four (4) years, we feel that much has been accomplished to insure safety in electrical work, and any effort to establish a code of safe practices in the operation of High Tension power will receive our hearty support.

W. Greenwood*: For safety men to butt in on the question providing and installing control equipment with a view of making operation of electrical equipment more safe, may seem like expecting the child to instruct the parent. There is but little if anything to be said on the subject of installing and operating it, so far as knowledge has come from practical experience and from research work, that has not been said in a code that is accessible to all of us. The safety men present themselves to this association in an humble frame of mind and ask to be informed on what safe installations consist of without going extensively into the intricate details of construction, generating current, its characteristics, etc., so that they may be able to check up on installations and understand from the cause of an accident whether or not proper installation and method of operation had been complied with.

When we come to discussion of control equipment it is not easy to say just where the discussion should begin and where it should end. If every matter pertaining to control were included we would cover much ground, and in no way could the National Electrical Safety Code be abbreviated. We would include insulation, isolation, grounding, remote control of switches, automatic high and low voltage circuit breakers, operating controllers, wiring and various other matters that have a bearing on making the operation of electrical equipment free from hazard.

It seems to me that what is wanted is condensed descriptions of methods that will inform each operator of any part of equipment concerning its functional characteristics fully enough to enable him to handle it intelligently, without accident to himself or the equipment, and that will be a guide to investigators when trying to determine whether or not an accident occurred through fault of the equipment or the method of operating it.

Speaking of education, in the excellent paper contributed by Mr. Hughes, we find at the head of a list of contributing causes of electrical industrial accidents, "Ignorance." We very naturally are inclined to assume that ignorance on the part of one who gets injured is inexcusable. Is this a reasonable conclusion? While it is possible for anyone to educate themselves on any subject, are we sure any-

*Safety Engr., Carnegie Steel Co., Youngstown, Ohio

body will take advantage of their opportunities unless some stimulating influence creates a desire? The paper mentions what provisions, on the part of the management, should be made for avoidance of accidents. Where the matters of providing miniature switchboards in power houses, requiring the keeping of logs, supplying telephones, furnishing good lighting and supplying designating cards for attaching to circuits have not been complied with, we are prone to charge accidents to carelessness even though such neglect may have been a contributing factor in the various cases.

We meet here for educational purpose and all our discussions are for the same purpose. Must we assume that all the knowledge we gain, which is as much needed by others, is transmitted to them by the simple process of radiation without effort on our part? If the class of men usually employed in the industries are to be protected from accidents by education, as well or better than by safe construction of equipment, we must proceed to educate them by some means that is simple other than by talking in conventions, talking through magazine articles or by supplying mandatory rules that are simply commands without information as to why obedience is necessary .

It seems as though our efforts toward educating those who are most exposed to injury from burns, shocks or contact with electrically operated equipment, might be made more effective. The same statement might be applied in regard to our course toward those higher in authority but not directly connected with operating. To provide equipment that will make operating as nearly absolutely safe as possible requires, in some cases, larger expenditures than is required for equipment that is not as free from hazard. To provide in such cases against this hazard to persons also means providing against injury to equipment, and when the loss from such injury is considered we find it is very profitable to install the equipment that provides against mishaps. As instances we can allude particularly to providing interlocks between oil switches and disconnecting switches on high tension equipment, that will prevent opening a disconnecting switch without first opening the oil switch or closing the disconnector with the oil switch closed; to providing circuit breakers of sufficient capacity to care for the entire generating capacity of an installation in case a surge occurs from any cause; providing remote control where the hazard of close contact with high tension equipment is great. Absence of these provisions go toward making ignorance in some measure excusable.

What practical methods have we to offer for getting the education so easy for us to acquire, on to those who are exposed and those who suffer? This is the matter that should be greatest in importance. I am optimistic enough to believe our Association will develop the methods of education that will enable operators of equipment to easily acquire such knowledge of functional characteristics as will better enable them to intelligently operate their equipment and do it safely. I also have faith to believe our Association will be able to show the higher authorities the economy of providing the highest standard of control equipment that has been developed.

Education consists of something more than preaching and exhorting; something besides telling of consequences; something besides informing that the victims of accidents are responsible because of their ignorance and that accidents will occur so long as ignorance prevails.

C. L. Baker*: Mr. President, members of the Association of Iron & Steel Electrical Engineer and Guests:

For the third consecutive time at the annual meeting of the Association of I. & S. E. E. the Safety Engineering Division is in session.

Since our Chicago meeting last June, electrical accident prevention work by this Association has been given active attention in the Iron and Steel Industry throughout the country, and we are all, I believe, of the firm opinion that every effort we have given this life saving movement has been certainly worth while; and I am confident that it is the intention of every member here today to better, during the coming year, every record they have ever established in the past.

I have no intention of taking up your time in going into details as we have on our program some very interesting papers for reading and discussion, all of which will introduce the main topic of our safety program for next year, which will deal with the many circumstances surrounding "Safe Practices in Connection with the Operation of High Tension Power."

I do, however, wish to point out from a statistical standpoint a few of the high water marks in electrical safety. During the past year the Fourth Annual Safety Engineering Conference of Western Pennsylvania Safety Council featured electrical safety on their program, and in the State Wide Conference of Safety Engineers with the Department of Labor and Industry at Harrisburg, electrical safety received its share of attention and also at a number of other safety meetings throughout the country.

I am happy today to say to you that the safety standing of the Electrical Department in the Iron and Steel Industry compares favorably with any department in the entire industry and I feel that you men assembled here should be complimented on the position in which you have placed your department in comparison with the other operating departments of our industry.

You are naturally interested in knowing where the electrical department stands in comparison with other departments in the Frequency Rating of Lost Time Accidents based on 1,000,000 hours of exposure, and I am more than pleased to quote you some comparisons given by Lucian W. Chaney of the Bureau of Statistics, U. S. Department of Labor, which I trust you will record mentally or otherwise:

	Frequency Rating of Lost Time Accidents Based on 1,000,000 hrs. of Exposure					
	1910	1910-14	1915-19	1923	1924	1925
Iron and Steel Industry	74.7	59.2	41.6	33.2	30.8	28.11
Electrical Department	62.7	47.1	40.3	17.6		

While we do not have the figures from the Bureau of Statistics on the electrical department for the past two years, we are of the firm opinion that our de-

*Management's Representative, Bethlehem Steel Co., Johnstown, Pa.

partment has kept pace with the industry in the reduction of the Frequency Rating of Lost Time Accidents, as they have in the past.

I wish at this time to pay our respects to Dr. Chaney for his wonderful work in recording and tabulating statistics of the milestones in accident prevention work in the Iron & Steel Industry, particularly since 1913. Since that date he has been able to keep a record of a section of the industry which includes the plants who have done the most persistent and effective safety work and these plants include approximately 50% of those employed in the iron and steel industry.

Our industry has been the pioneer in accident prevention work and its strenuous efforts to control accidents has been crowned with success. The figures just submitted demonstrate that accident prevention work, properly managed and directed will produce results that can not be measured in dollars and cents.

But, we are not so good, however, that we can not improve our standing. It must be born in mind that there is a considerable portion of our industry that is not giving the safety movement the consideration that it so well deserves.

During the past year, the electrical departments in a large number of steel companies have done outstanding work along safety lines and from reports I have received from a number of companies and individual plants, some of which are the largest in the country, operating from coke ovens down through to small finished products, their electrical departments have operated not only one continuous month at a time without a lost time accident, but a large number for continuous months without a lost time accident. One of the large plants in the Pittsburgh district operated during the year 1926 with only two lost time accidents in their electrical department.

These performances, to my way of thinking, are marvelous and point the way for even more strenuous observance of safety by the electrical men in the steel industry.

Our past performance in the electrical field is the signboard pointing the way to still better results that can be accomplished by the electrical men in the future.

C. B. Auel*: When I accepted the invitation of my good friend Baker to take lunch with him today, I had no idea that I would be served up as part of the afternoon program, and while I appreciate the compliment he intends to convey to me in so doing, I do not relish extemporaneous speaking. It is inevitably rough going for the speaker and usually rough listening to on the part of the audience. However, while I am on my feet I want to talk to you briefly on two matters closely allied to the subject of safety, and in which I feel sure all of you, representing employers of labor as you do, will be interested; and if so, I want further to solicit your co-operation to the extent of advocating these matters publicly as opportunity may offer, because we intend to present both before the next session of the legislature, and we shall need all of the backing we can possibly get if they are to have any chance of going through.

The first of these has to do with the employment of handicapped workers; whether they have been handicapped as a result of accident, or whether they have been handicapped as the result of disease or otherwise. As you know, many concerns will not employ handicapped workers of any kind. Other concerns will employ those whom they may have handicapped. In any event, there are large numbers of handicapped workers only too willing to work, who would do good work if given the opportunity, but who perforce must enter our poor houses throughout the land. The idea is to present a bill before the legislature, empowering the Department of Labor and Industry at its discretion to register all handicapped workers who apply to them for jobs. Upon their registration, they will be given a registration card duly setting forth their handicap and which they may then present to any employer. If the employer can find a job for these workers, he will be relieved in the event of further injury to such workers of the payment of compensation. It seems to me that if employers can put a bill like this through the legislature, it will redound to their everlasting credit and the opportunity presented to do something of this kind should not in my own judgment be foregone. Of course, one would not know how much such a bill would entail in the way of expense on the part of the state; so that the idea would be to commence work of this kind very gradually, as for example, only registering certain handicapped workers, say those who had lost one eye, one arm, or one leg; and after the state had had opportunity to ascertain what the carrying of the compensation for such worker would cost, the state would then further extend the classes of handicapped workers, whom they would register and would take on in due course, workers who may be partly or wholly blind; or who may be partly deaf, or totally deaf; or who may be crippled and whether born so or made so by disease or by accident. As the years go on, I think we can in this way place a large percentage of the handicapped and thus keep them out of our poorhouses. It seems to me that the state as a servant of society, can well be asked to take on work of this kind.

The other matter on which I wished to speak has to do with compensation. Compensation laws, as you know, are becoming more high powered with the passing of almost each state legislature. Each state's compensation law now has one or more high spots, and every other state is endeavoring to have incorporated in its own state laws, the high spots of other states. New York at the present time pays a maximum of $25 a week and endeavor is being made to raise it to $30. New Jersey pays $17 and is making every effort to raise it to $20. Pennsylvania is being pointed to as a state paying compensation away under that of New York or New Jersey. It is also being pointed to as not having certain requirements such as Wisconsin and several other states, where, in the event of the safeguard being missing, compensation is increased three-fold, and so on.

Workmen's compensation laws are being more and more liberally interpreted by the courts and referees and being made to include matters that they were positively never meant to include. I can best express these facts by one or two examples which I have spoken of on previous occasions. In our state, can you conceive of a verdict having been rendered against a manufacturer for an employe

*Westinghouse Elec. & Mfg. Co., Past President of National Safety Council.

working in a steel mill who had an attack of delirium tremens. It would be funny if it were not so serious. Again think of an employe working for a brewery being sun struck. Still again, in a western state a meat packing concern was compelled to pay compensation for an accident because an employe in going to work had to cross a railroad track and he was run down by a train and killed while still some distance from the employer's premises. The verdict was rendered against the employer because the law read: an injury arising either in the course of or out of employment is compensable.

Under the circumstances, it seems to me employers should no longer pay the entire expense of compensation, but be entitled to call upon their employes to help carry this ever-increasing burden. The idea would be this, that if the employer's rate was $1.50 per $100 of payroll, then the employe's rate would be some fractional part of such compensation cost, say 10 per cent. Ten per cent of $1.50 would be 15 cents and every employe in the establishment would during the course of the year pay 15 cents per $100 of wages. If, for example, an employe received $2,000 in wages per year he would be asked to contribute a total of $3 per year as his part of the cost of carrying the compensation burden.

This idea is practically new in this country, although Oregon has it in force not on a pencentage basis, but on a direct money value. It is also in effect in a number of European countries.

If you are agreed that these measures sound reasonable and logical, we solicit your support.

John Oartel*: It is a pleasure as president of the Western Pennsylvania Safety Council to extend you a welcome. This is the largest safety council in existence; it is one which covers more territory than any existing council. You started organized safety. You did not know what you were doing then, but men like Walter Greenwood, who have been with you and with us ever since safety was started, know that it has been an extremely worth while job. I would like to tell you out of my own experiences a few things that indicate to me that safety is worth while; that it is constructive in that it promotes the health, happiness and well being of every man, woman and child in the community.

At Buffalo a year ago, before the meeting they had a little dinner at the Chamber of Commerce. Before the Chamber of Commerce took on this local safety council as one of its activities they were at a loss to find a point of contact with the community. The president of the Chamber said before that time we were a thing apart in the City of Buffalo; but since we took over the local safety council, we have had a point of contact with the citizens of Buffalo because we are specializing in the saving of lives and limbs.

Out here at East Pittsburgh is the Union Railroad affiliated with the Carnegie Steel Company. It is only about 50 miles long, but it operates more car miles than any railroad of its size in a year's time in hauling ore and materials for steel mills. It has held the best record in the Carnegie Steel Company for reduction of accidents for some time. Of course that is always an interesting subject to me. Having lunch with the manager a few weeks ago, I asked him about it. He said, do you know since our railroad has been making such a drive on accidents and reducing them, we have a better feeling among our men. We are doing more work with less men and there is a better feeling all around; and so I want to impress on the Association of Iron and Steel Electrical Engineers that when we support safety we are doing something constructive. So it is a pleasure as president of the Safety Council of Western Pennsylvania to say a word of welcome to you and can assure you that I am one of you in supporting the same cause.

G. E. Clarkson*: I am certainly very happy to be with you today. I did not come here to contribute anything worthwhile but to get some of the good safety stuff you are handing out. It is true that I did have something to do with the safety activities in Western Pennsylvania mentioned by Mr. Baker. We feel rather proud of what we have accomplished, but I can assure you that we could not have accomplished anything like we have in safety had it not been for the fine support and assistance of such fellows as our president and others who are helping to put over the job.

I was rather impressed by the remarks of Mr. Greenwood along educational lines. Now, our job is very largely educational. We cannot readily measure the results for it is a difficult task. I want to add this, however, we have recently made a study of the Department of Labor statistics covering the eight industrial schools conducted in this district by the Safety Council and we have found when the schools had been started and conducted from six to eight weeks the accident curve invariably went down from 15° to 45°. Now that is the nearest to an exact measure we have of knowing whether or not we are getting results. This occured in eight centers where schools were conducted. I am proud to say to you that we have over 10,000 men registered in our eight schools in Westerr Pennsylvania.

I wish to thank you, Mr. Baker, for the privilege of saying a word.

A. J. Standing†: I read these papers in advance and enjoyed the discussion, and particularly the talks by our members in the safety end of the game. There is one phase of this high tension subject that is not receiving quite the attention it should today and that is the care that should be taken during the time of construction or installation, and particularly the transition from one system to a new or different system. We find that is one of the most hazardous periods in our operation. Take a plant where you have a number of installations running along smoothly, if you put in a new system you are introducing different conditions and often under the pressure of time men don't have sufficient time to adapt themselves to the new conditions. You may have in a machine shop, men who run cranes while changes are being made to the roof, building design and power line equipment. We cannot dwell too much on the need for care and reasonable amount of time in letting these men on a construction job understand the risks in the neighbor-

*Chief Safety Engineer, Carnegie Steel Company, Pittsburgh, Pa.

*Executive Secretary, Western Pennsylvania Safety Council, Pitssburgh, Pa.

†Elec. Supt., Bethlehem Steel Co., Saucon Plant, Bethlehem, Pa.

hood. We all can look back on accidents in our past experience which are chargeable to any one of these conditions I have mentioned, and I think we can well afford to hold back the starting of new equipment, take a little more time, increase the delay a little if necessary in order to be a little safer on some of our hazardous construction work.

C. L. Baker: Mr. Standing has brought out a very good thought in regard to safety work.

James Farrington*: I would like to ask Mr. Cartwright or any other person if they would consider it safe to close pole type switches with voltages on the line instead of using the oil switch.

A. N. Cartwright†: Whenever an oil switch is available for closing or opening the line, it should be made use of instead of a pole top switch. However, a pole top switch may be used with safety. The condition under which the switch is closed or opened entirely governs the operation that should be made. It is perfectly safe to close a pole top switch under certain conditions and very wrong under other conditions, as for instance, in picking up a line on which there is not a large load, the operation is entirely safe. If you are de-energizing a line or piece of equipment on which there is less load, it is entirely safe to open the switch, provided the opening space and the phase spacing is sufficient and the switch has been tested under more severe conditions than would prevail in your operation. In other words, a switch should be tested before being used for opening or closing live circuits, i.e., the switch should be tested by opening and closing it under power load conditions at the voltage on which it is to be installed to determine the loads which it will break under these test conditions, which would then be given a factor of safety of three or four under actual operating conditions.

W. C. Obert‡: I would like to ask Mr. Cummins or Mr. Cartwright on the proper method of safeguarding ladders. We find there is a great difference of opinion in a good many plants; some absolutely requiring guards and some other plants will not have guards of any sort on ladders on which men are going to work. Some advise ladders with intermediate platforms.

A. C. Cummins§: Mr. Obert has presented a question which is of great interest to the electrical engineers of the steel industry at the present time. Many of you know that steel mill power systems are being developed to the point where long span high tension power lines are being constructed for power transmission purposes. The public utilities have expressed themselves as opposed to ladders or platforms on towers and their position is based on the following conditions:

(1) A backguard may prove hazardous because a man must carry tools and equipment up and down such ladders and the nature of this material is such as to make it extremely difficult for him to climb without catching his tools or equipment on the guard. Such conditions not only prove a handicap in climbing but also may be a source of danger if the material becomes loose and falls to the ground while men climb the ladders.

(2) That electrical clearances required in high voltage transmission make it impractical to provide working platforms on line towers which are a real protection to the worker. And therefore such platforms as may be provided are only false security.

(3) Men who climb towers are always of the most expert class and it is desirable to discourage all others from mounting high tension line structures.

On the other hand the argument in favor of back guarded ladders which holds weight seems to be that backguard permits a man resting while climbing a long ladder. Just recently it was my privilege to watch the construction practices on a high voltage line and to talk with the various workmen engaged in this construction program. These men were very emphatic in opposing backguarded ladders. They did not even care to use the ordinary corner pole steps with which transmission towers are provided and instead were making a current practice of climbing up over the structural members. They did not use safety belts stating that they were more of a hazard than a safeguard in erecting towers of windmill type construction. It has also been my privilege to question the executives of a number of different power companies who construct and operate tower lines of this type and find that in four very large companies there has never been a fatality due to a man falling from a tower, except when he had previously been shocked and made unconscious by contact with a live line. There is no safety ladder or platform which would guard against such conditions, and it is my personal opinion that they should be omitted from tower line structures of the windmill type, except very high towers, where special conditions permit an adequate design. There is no doubt that this subject has been given much study by our friend Mr. Cartwright, and it would be interesting to hear what he has to say.

A. N. Cartwright: As far as backguard in public utility structures is concerned, you will find their answer by their absence. There has never been shown by our accident record the necessity of backguard for the tower. In fact, we tried to discourage the climbing of sub-station structures to a very great extent. If at a point where it is possible, we require the men to work from ladders rather than go on the structure. On the tower itself, that is one of the safest things the man does. After he is up on the tower he is working from a ladder normally suspended from the cross arm. He uses his safety belt generally, but a backguard or anything of that sort would be of such a nature that it would hinder him in the work he is doing. There is many times the amount of work done on the tower in its erection than there is ever afterward. Our answer is the absence of them on the system.

Walter Greenwood: In a general way I agree with what has been said in regard to supplying backguards for ladders, although I cannot endorse all that has been said. Experience has taught me that the backguard on a ladder gives one who is climbing it better nerve, or rather a feeling of security. Inasmuch as one is free from nervousness

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*Elec. Supt., Wheeling Steel Corp., Steubenville, O.

†Genl' Supt., Power Div., West Penn Power Co., Pittsburgh, Pa.

‡Tower Dept., American Bridge Co., Frick Building, Pittsburgh, Pa.

§Elect. Supt., Carnegie Steel Co., Duquesne, Pa.

in doing a thing that is in any degree perilous, they are not so liable to meet with an accident, and for that reason we must class backguards with the useful safeguards. The ideal provision for getting up on towers would be to provide stairways, but those who provide equipment must be guided by the expenditure they can afford, and this in many cases must be justified by the hazard it reduces. Since the situation is influenced by dollars and cents to the extent we cannot obtain ideal conditions, we must be satisfied with the next best.

John Oartel: I think what Mr. Greenwood wanted to say was that the backguard furnished a moral support.

A. N. Cartwright: One of our difficulties is the preventing of the men from performing circus stunts on the tower. The general character of the men who do this type of erection work is such that they would scorn the use of backguards and we are also very severe in the penalizing of men for showing off and taking undue risk.

C. L. Baker: I believe everyone who has listened to the discussions and reading of papers, feels that we have a real job before us for the next year in our safety program and it is our hope that considerable activity from all divisions will be manifest to a high degree in this Association during the coming year on this particular subject. I personally feel that we all will be well repaid for any work and time that we put on this very important subject.

I am certainly pleased to note the attention and demonstration of "sticking it out" that you fellows have given here this afternoon. In other words, you stayed on the job and your attention has been excellent; and we certainly appreciate the fellows who prepared the papers. During the coming year, the Safety Division needs the help of everyone of you men, especially that of the electrical engineers in conjunction with that of the safety engineers of this Association.

We have had fine co-operation ever since we formed our Safety Division and I can only ask for the continued interest of every member of the association in our safety problem this year, which is as you know, "Safe Practices in Connection with the Operation of High Tension Power."

We hope our proceedings this afternoon have been interesting to all of you and I am sure that our next year will show progress in this safety activity.

Electric Locomotive For Hot Mill Service

By DAVID J. MUNRO*

THE interest of steel men, throughout the country, has been centered of late on a development which competent authorities declare will result finally in the complete electrification of transportation in steel mills.

A large steel company in a plant in the Pittsburgh District has recently installed an 80 ton, 230 volt D.C. locomotive for hot metal service. The locomotive was specially designed and built by the Baldwin Locomotive Works and the Westinghouse Electric and Manufacturing Company in co-operation with the steel company, to meet the severe conditions under which it has to operate, and contains some special and unique features.

The locomotive operates between the "Bull Pen" (where the empty ladles are cleaned) and the "Mixer Building," hauling hot metal ladles to the mixer and bringing back the empty ladles to the "Pen" for cleaning and inspection. The engine goes into service every Sunday about 10:00 A. M. and stays in service continuously until the following Saturday morning. This unusually severe service is being met successfully by the locomotive, week in and week out.

During one complete cycle, the locomotive travels approximately 7900 feet. This includes switching operations as well as straight running. Of this distance, 750 feet are on a 2¾% grade against a loaded train and 600 feet on a 2¾% grade with a 19° curve throughout its length, also against the loaded train.

With steam operation, 20 minutes were required to make a complete cycle and a layover of 4 minutes was provided. The electric locomotive, hauling one more ladle than the steam engine, makes the complete cycle in 15 2/3 minutes. The average haul consists of four loaded ladles, weighing 70 tons each, and one "safety car" weighing 25 tons. Frequently during the day five ladles are handled and during the acceptance tests on the locomotive, a five ladle train was successfully started without the use of sand on the section of track containing the 19° curve and 2 3/4% grade.

Mechanical Construction

The mechanical parts of the locomotive were developed for the unusually severe service for which they were intended, special precautions being taken to protect the wearing parts from dirt and grit.

The cab is of the steeple type with a hood located at each end to house the blower and compressor equipment. It is carried on two swivel trucks of special design, giving a B-B wheel arrangement. The engine will traverse a 75 foot radius curve without a trailing load and a 150 foot radius curve with a trailing load.

The truck design is new and results in a smooth riding engine, thus decreasing excessive wear on parts and increasing their reliability.

The truck bolster is made of cast steel, liberally designed, and is rigidly bolted to the truck side frames. The center pin seat is of the flexible type, supported by means of hangers and semi-elliptic springs hung from the truck bolster. It is this feature of the truck design that is mainly responsible for the excellent riding qualities obtained. A sheet metal guard around the center pin prevents any grit

*Railway Equipment Engineer, Westinghouse Electric and Manufacturing Company.

or other injurious substances from getting in contact with the wearing surfaces.

Each truck is provided with spring supported side bearings to limit the lateral roll of the locomotive cab. Equalization is obtained through equalizer bars on each side of the truck side frames. These bars rest on the journal boxes and are loaded through semi-elliptic springs.

The cab underframe is such as to embody both strength and lightness. Due to the swivel truck arrangement, the total draw bar pull exerted by the main motors is transmitted through the cab under-

FIG. 1.

framing. Great strength and rigidity are necessarily, therefore, the primary requisites of the underframing. This was obtained by building the frame of rolled steel channel side and center sills, connected to the transverse members of the underframe by means of knee castings.

The cab is built up of standard Z bars and rolled steel sheets. The entire frame work is thoroughly braced and fastened to withstand the shocks and bumps to which it is subjected. The interior of the cab is arranged with a central equipment compartment. An aisle down each side of the cab connects the engineman's compartments at the ends of the locomotive. The equipment compartment is completely enclosed for safety, and removable doors are provided to give access to the equipment for inspection and repairs. Ventilators are provided in the roof of the cab directly over the equipment compartment to provide adequate ventilation for the grid resistance. Expanded metal doors at the base of the compartment, with solid doors at the top, produce a chimney effect and a continuous flow of cooling air is provided through the resistance.

A coupler centering lever and platform uncoupling device are provided at each end of the locomotive to meet the Steel Company's safety rules, which prohibit the coupling or uncoupling of hot metal ladles by men standing on the ground.

An interesting and important departure from common practice is made in the construction of the equipment compartment and supports. The supports are electrically welded in place instead of being riveted. This type of construction has many advantages over the older method, including light weight, elimination of gusset plates, neat appearance, greater standardization, etc.

The chief locomotive dimensions are as follows:

Length between coupler knuckles	41′ 2½″
Height from top of rail to roof	11′ 11½″
Total wheel base	28′ 8″
Rigid wheel base	8′ 8″
Truck centers	20′ 0″
Width overall	10′ 6¾″
Wheel diameter	38″

Locomotive Weights:

Mechanical parts, including sand	104,621 lbs.
Air brake	4,963 lbs.
Electrical equipment	49,048 lbs.
Total locomotive	158,632 lbs.
Weight per axle	39,658 lbs.

Electrical Features

The locomotive is equipped with four type 345 railway-motors, rating 145 H.P. each at 230 volts D.C. The A.I.E.E. motor ratings are as follows:

	Volts	Amps.	M.P.H.	T.E.
Hour Rating	230	555	8.9	5,840 lbs.
Continuous	230	350	12.1	3,050 lbs.

Maximum guaranteed T.E. 39,658 lbs., limited by 25% adhesion.

The electrical circuits of the locomotive are arranged to permit the locomotive to operate from the regular steel mill ungrounded supply at 230 volts D.C. Power is collected from positive and negative third rails, mounted one vertically above the other.

The main motors are arranged in two groups connected permanently in multiple. Bridging transition is used between the two motors composing the group giving a double bridging control arrangement.

The grid resistance and switch arrangement being in duplicate permits a very symmetrical and economical arrangement of equipment.

The two main fuses are connected, one in each side of the line, and are mounted on the cab underframing between trucks. The size of the fuse made it necessary to mount the fuse box outside the locomotive to ensure the necessary diffusion of the generated gases. The location chosen is ideal from this viewpoint and also provides adequate protection from the elements. The fuse boxes are mounted sufficiently far from the trucks to be clear of all wheel wash, etc.

A double pole, single throw, main switch is provided to disconnect the main motor circuit.

An overload relay set at 1000 amperes is connected in each individual motor circuit. In the event of an overload occurring, any relay operating causes the entire locomotive to be cleared from the line. A single switch governs the resetting of all the overload relays.

A motor cutout switch is included in each motor circuit. These switches are electrically interlocked so that if one switch is opened, the corresponding motor on the other truck is also disconnected from the circuit. This permits operating the remaining pair of motors up to the full parallel connection.

The rotating auxiliary equipment consists of two blower equipments, and two 50 ft. air compressors. All are driven by 230 volt D.C. series motors. Suitable fuses and circuit breakers are provided to give the necessary protection against short circuit or overload.

Control energy is obtained from the line through a suitable resistor and is applied to the control circuits at 110 volts. The control switches and equip-

ment are of the Westinghouse standard electro-pneumatic type.

Electro-pneumatic valves, controlled from a push button station in front of the operator, govern the operation of the third rail shoes. Individual control of each pair of third rail shoes is provided. This is to take care of future operation, which will necessitate raising the shoes to clear buildings, etc. The shoes are air lowered and spring raised, with an air controlled release toggle to raise the shoes.

Two reversers control the direction of rotation of the locomotive. Their control circuits are so arranged that the locomotive cannot be operated unless both reversers are "thrown" to give the correct rotation of main motors.

Special Features

The grid resistance was specially designed to meet the steel company's specifications, which called for capacity sufficient to enable the locomotive to operate on any notch of the master controller, except the first, for a period of four minutes without undue heating.

These unusual requirements necessitated the use of 32 frames of resistance, having a total weight of 4900 lbs. arranged in two rows, double decked, with eight frames per row. Adequate ventilation is provided to carry off the heat generated by the severe service conditions.

Due to the extremely low operating voltage, the currents to be handled require leads of considerable section. In order to obtain sufficient flexibility, it is necessary to use two cables in multiple between the third rail shoes and the main fuses. This condition, with the added complication of negative leads led to an innovation in cable arrangement which appears most satisfactory. Positive and negative bus bars, made of ½"x3" copper strap, are mounted underneath the cab underframing along each side, parallel to the longitudinal axis of the locomotive. A bus bar is also used to connect the longitudinal bars of polarity. All leads from third rail shoes, fuses, etc., are connected to the bus in the most convenient locations. Perforated metal guards, made in convenient lengths, provide adequate protection against accidental contact with the bus bars.

The initial performance of the locomotive is eminently satisfactory and augurs well for progress in the electrification of steel mill yards. The first week's operation proves beyond a doubt that the electric locomotive can handle a much heavier load, in less time, with a greater degree of safety and smoothness, than is possible with a steam locomotive of the same weight.

New Sheet Bar and Skelp Mill at Indiana Harbor

By A. E. BEARDMORE*

A NEW continuous sheet bar and skelp mill has recently started production at the Indiana Harbor Plant of the Youngstown Sheet & Tube Company. Fig. 1 shows two of the motor generators and two synchronous converters in the foreground with a 7500 h.p. induction motor, the largest Kraemer controlled motor in the world, in the center of the picture. The three 2000 h.p., d-c motors are shown on the left. Fig. 2 shows the switchboard and part of the control.

In order to illustrate clearly the scheme of operation of the main roll drive motors and the regulating equipment, the elementary connections of the machines are shown in Fig. 3. There are five main roll drive motors and one edging roll motor. Two of the motors are adjustable speed induction motors controlled by modified Kraemer equipments and are shown as IM-1 and IM-2 on the sketch.

The three remaining main roll drive motors are d-c. adjustable speed machines and receive their power from motor generator sets. The smaller of the two induction motors is rated 3600 h.p. at 290 r.p.m and, with a modified Kraemer equipment, will operate on a constant torque basis down to a rating of 1940 h.p. at 156 r.p.m. It is possible to operate the equipment at a still lower speed with a slightly reduced torque.

This motor is shown as IM-1 in the sketch. Its primary or stator winding is connected to the 2200-volt, a.c. power supply, while the secondary winding is connected through the slip rings to the a-c. side of the synchronous converter, R-1, which converts the slip energy of variable potential and frequency into direct current. The direct current from the converter is brought to the d-c. machine D-1, which forms part of a high speed, 4-unit, motor generator set driven by a synchronous motor shown as TS-1 on the diagram. The speed of the motor IM-1 is adjusted by changing the field of machine D-1 which in turn changes the voltage opposing that generated in the secondary winding of the motor. Two of the synchronous converters R-1 and R-2 of the high speed 4-unit motor generator set are shown in Fig. 1.

As the a-c. motor is inherently a constant torque motor, the method of speed adjustment follows the general line of the well known Kraemer system with the necessary modifications to give the motor a constant torque characteristic. A conventional Kraemer equipment has a d-c. motor direct connected to the shaft of the induction motor. The slip energy of the induction motor is converted into direct current at the proper voltage and used by the d-c. motor. The two motors on the same shaft make a constant horsepower equipment. The modified Kraemer system described utilizes the slip energy of the induction motors for driving the 2000-h.p., d-c. motors

*Industrial Engineering Department, General Electric Company.

without returning the energy to the power distribution system. In case the 2000-h.p., d-c. motors are not loaded at the same time that the induction motors are loaded, the slip energy of the induction motors is returned to the power system through the motor generator set.

The induction motor IM-1 is started in the conventional manner by means of a resistance in the secondary circuit which is cut out in graduated steps as the motor approaches synchronous speed. The conventional control equipment is arranged so that the last accelerating contactor in the secondary short circuits the slip rings of the induction motor. The control equipment used with the modified Kraemer equipment (Fig. 4) is so arranged that, when it is desired to run regulating, the last accelerating contactor in the secondary connects the slip rings of the induction motor to the slip rings of the synchronous converter, and then the secondary resistance is disconnected so that there are no losses in the resistor during normal operation. A system of interlocking insures that the d-c. machine will not generate any voltage at the time the transfer is made.

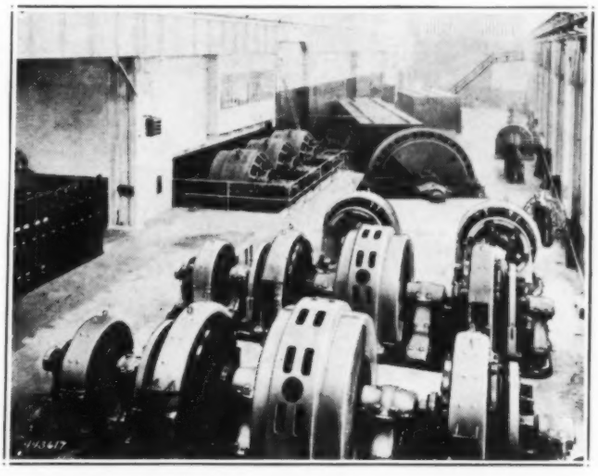


FIG. 1—Motor room showing electrical equipment for continuous sheet bar and skelp mill of Youngstown Sheet & Tube Company, Indiana Harbor, Ind.

The operations described are controlled by a master switch located in the pulpit. If it is desired to plug the motor IM-1, the master switch is moved to the reverse position. This trips the solenoid-operated forward oil circuit breaker and, after a predetermined time, disconnects the slip rings of the induction motor IM-1 from the slip rings of the synchronous converter and connects them to the secondary resistance, at the same time closing the reverse oil circuit breaker. Stopping the motor is accomplished by bringing the master switch to the "off" position which opens the oil circuit breaker and disconnects the regulating equipment. The equipment can be operated "regulating" in the forward direction only.

The speed of the induction motor shown as IM-2 on the sketch is controlled in the same manner as the speed of IM-1 just described. This motor, shown in Fig. 5, is the largest Kraemer controlled induction motor in the world and is rated 7500-h.p. at 250 r.p.m. With the modified Kraemer equipment, it will operate on a constant torque basis down to 4040 horsepower at 134 r.p.m. It is possible to operate the equipment at a still lower speed, with a slightly reduced torque.

The motor IM-2 is twice the capacity of IM-1, and two synchronous converters R-2 and R-3 and two d-c. machines, D-2 and D-3, are used to obtain the speed regulation. By using this arrangement,

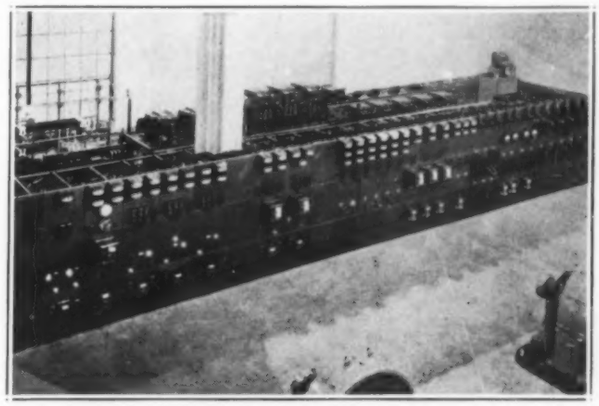


FIG. 2.

all of the converters as well as the generators are duplicates and interchangeable, making a more desirable and flexible equipment than would be obtained by using one larger d-c. machine and one synchronous converter of double capacity. In case of reduced load, only one machine (D) and one converter (R) will be used for regulating the speed of the motor IM-2, thereby increasing the overall efficiency of the drive.

The three 2000-h.p., d-c. motors are mounted on a common base as shown in Fig. 6, making an unusu-

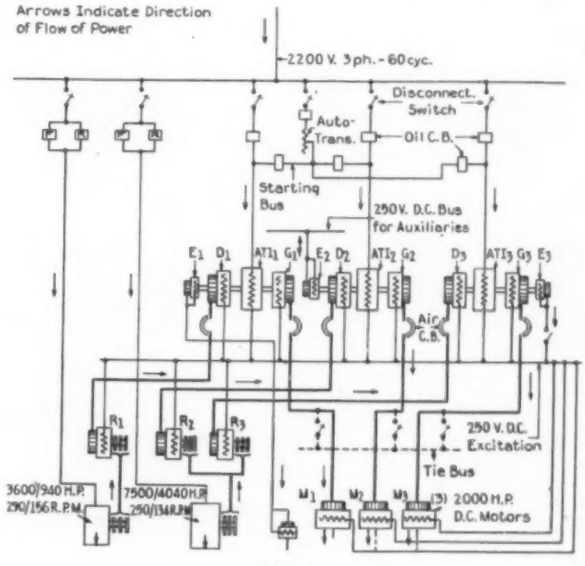


FIG. 3.

ally compact arrangement. The motors, which are duplicates, will each be capable of developing 2000 horsepower, with 600 volts supplied to the armatures, and will operate through a speed range of 85 to 165 r.p.m. by field control. It will be possible to reduce the basic speed of any of the three motors below 85 r.p.m. by reducing the generator voltage below its

rated value of 600 volts, and provision is made for operating at reduced voltage. Since a generator is provided for each of the motors driving the finishing stand, full advantage can be taken of the Ward-Leonard system of control for starting, stopping and reversing each motor independently and for operating at the desired speed without interfering with the operation of the other motors. These motors are

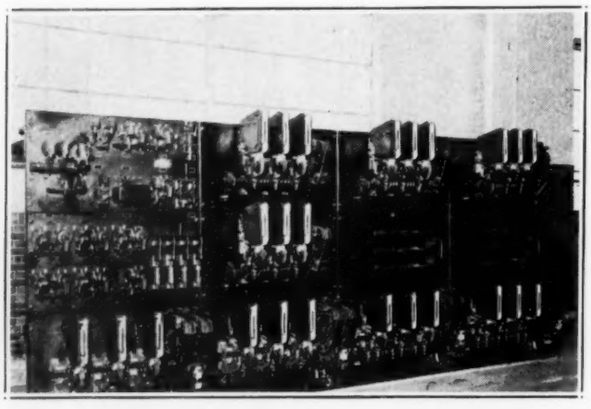


FIG. 4—Secondary magnetic control panel for 7500/4040 HP 250/135 RPM 2200 volt Kraemer equipment.

forced ventilated and will operate at reduced speed without reducing the torque below the rated value.

Each of these motors receives power from a separate generator (G) and will be started by the Ward-Leonard system. There are two rheostats in each generator field circuit. One is the starting rheostat and the other the regulating rheostat. The position of the regulating rheostat is not changed when the equipment is shut down, so that when it is desired to restart it is only necessary to run the starting

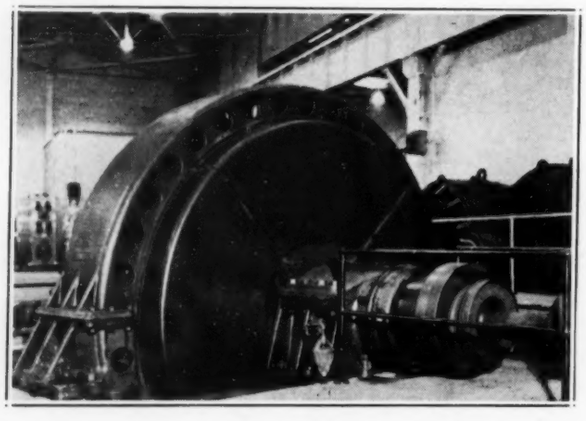


FIG. 5—The largest Kraemer controlled induction motor in the world rated 7500 HP at 250 RPM and 4040 HP at 134 RPM.

rheostat to its extreme position and the previous setting is again obtained. This arrangement saves a great deal of time when it is desired to start and stop several times while rolling the same section.

Each motor also has two rheostats in the field circuit, one a motor-operated rheostat for coarse adjustment, and the other a hand-operated rheostat for fine adjustment.

The d-c. generators G1, G2 and G3, and the d-c. machines (which may be operated as motors or generators) D1, D2 and D3, used for obtaining the speed regulation of the induction motors IM-1 and IM-2, are duplicate machines, each having a capacity of 1700 kilowatt at 600 volts. These generators are driven in pairs by 4400-kv-a. synchronous motors shown as TS-1, TS-2 and TS-3 in Fig. 3.

When the motors IM-1 and IM-2 are operating at reduced speed, the machines D-1, D-2 and D-3 will act as motors and will deliver mechanical power at their shafts. The synchronous motors are in this manner relieved of the necessity of furnishing the full amount of power required by the generators G1, G2 and G3. This direct transmission of the slip energy to the point where it is useful increases the overall efficiency and permits using to greater advantage the corrective kv-a. capacity of the synchronous motors. The very substantial amount of leading kv-a. furnished by the synchronous motors can be used to good advantage on the power system of the Indiana Harbor Plant.

To provide for abnormal conditions the synchronous motor driving each motor-generator set is of ample capacity to drive the two machines D and G

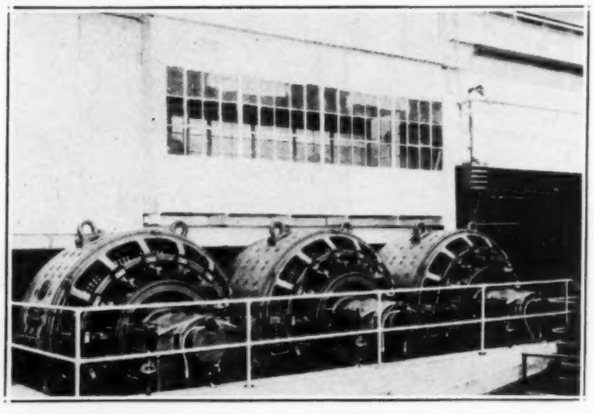


FIG. 6—Three 2000 HP 85/165 RPM 600 volt mill type direct current motors mounted on a common base.

and the exciter when all three machines are operating as generators carrying their rated load. This permits using any motor-generator set for power generation alone, if desired. In this case the advantage of having extra capacity in the synchronous motors will be fully realized.

As a result of using the large synchronous motors, the power factor of the total load on the mill will be leading both when operating at full load and maximum speed and at full load and minimum speed. With the mills running at less than full load at any speed, the amount of corrective kv-a. will be still greater.

The system of grouping the various machines to obtain the necessary speed regulation possesses several novel and advantageous features which make a simple, flexible and reliable equipment. Owing to the fact that all six machines D1, D2 and D3, and G1, G2 and G3 are duplicates and that the converters R1, R2 and R3 are duplicates, and swing to the arrangement of the equipment, an unusually flexible and interchangeable source of direct current supply is provided. By using duplicate machines and provid-

ing means for substituting one machine for another, more flexibility and protection is provided against break-down than by any scheme heretofore used for steel mill drive. For instance, in case of trouble with one of the converters, it will be possible to run the 7500-h.p. motor IM-2 at half capacity and in this manner get along with two converters for the drives IM-1 and IM-2. In case of trouble with any of the generators, the three 2000-h.p., d-c. motors may be furnished with power from the two remaining generators tied to a common bus, and arranged so that the motors may be started by Ward-Leonard control. If the three d-c. motors are taxed to their capacity, it will be possible to substitute machines D2 or D3 for the defective generator and run motor IM-2 at half capacity.

There are many other conceivable groupings of d-c. equipment which the operator may find advantageous for different conditions of rolling. The layout of the switchboard is such that any regrouping of the d-c. equipment may be very easily and quickly obtained by the operator.

A 250-kw., 250-volt exciter is provided on each of the motor-generator sets. One of these exciters will supply the necessary excitation for all motors and generators requiring d-c. excitation. One will be used for supplying power to the edging roll motor. The third exciter will be held as a spare, or may be used to supply power to the 250-volt circuit. In case of emergency, the edging roll motor may be driven from the 250-volt shop circuit.

The switchboard equipment shown in Fig 2 controls the incoming power and is arranged to give a complete record of the power consumption, fluctuation of load and other operating conditions. The arrangement is such that any switching or regrouping of the machines may be easily accomplished.

The control equipment centralizes the control of the main roll drives and edging roll motor on a small steel desk located in the operator's pulpit. On this desk are located the master switches, control switches, meters and rheostat controls, as shown in Fig. 7. All the controls for one motor are located on the same base. The master switches control the starting, stopping and reversing of the main roll drive and the edging roll motors. Load-indicating meters are provided for each of the motors.

Voltmeters, calibrated in r.p.m. and having scales so arranged that they can be read very accurately, are provided for each motor. The controls for the motor operated field rheostats and the levers of the

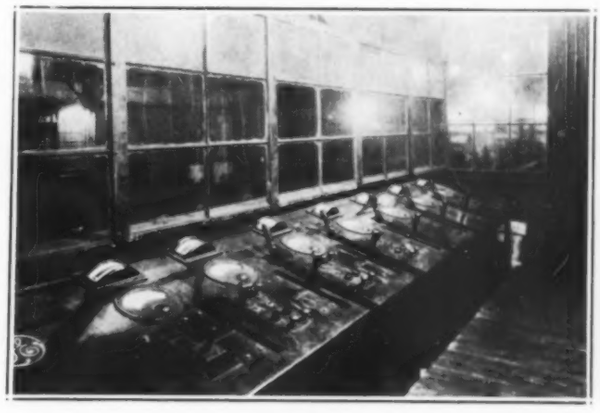


FIG. 7.

hand-operated motor field rheostats are located close to their respective speed indicators, so that the operator has complete and accurate control of the speed of all the motors. Control switches with indicating lamps are provided for resetting the d-c. air circuit breakers between the generators and the motors in case the breakers trip on overload. A system of interlocking is provided so that the pulpit operator cannot make a wrong connection.

Blast Furnace Flue Dust and Blast Furnace Control

By E. KIEFT*

THE Blast furnace flue dust production and recovery has been one of the principal topics of discussion among men connected with the steel industry and to a certain extent among parties living in the vicinity of steel mill centers. The former are directly interested on account of operation difficulties and financial losses due to flue dust production, while the latter are made to take notice on account of its nuisance, when carried into the dwelling places and its surroundings.

The problem becomes more pronounced when time goes on. The courser ores are not as plentiful as the fine ores. It is therefore that more attention has been paid to the flue dust proposition during the last decade.

*Engineer of Tests, Illinois Steel Co., Gary, Ind.

In the following discussions we will make a few calculations pertaining to cause of flue dust production, besides the importance of the necessary height between stock level and center of downcomers will be calculated with consideration of prevailing conditions encountered in practical operation. As a final, a most important question is brought up and discussed, which may lead to much improvement in connection with the prevailing flue dust situation.

1. Blast Furnace Flue Dust

Calculations pertaining to the maximum size of a flue dust particle that can be carried by the gases leaving the top of a blast furnace:

Let v=the velocity of the gases in feet per second;

g=the acceleration of gravity 32.2 feet per second;

d=the diameter of a flue dust particle of spherical shape in inches.

The spherical particle offers the greatest area and least weight against the current of the gases as compared with any other particle having the same weight but non-spherical shape.

W=weight of the particle in lbs;

K=Density of the particle in lbs. per cubic inch;

G=Density of the furnace gases in lbs. per cu. ft. at actual furnace top temperature and pressure. We find G about equal .05 lbs. per cu. ft. at 420°F and 42 inches water top pressure.

We have then according to the laws of action and re-action, maximum pressure against the particle, that is at the moment before it starts to move equal

P=pressure due to velocity head $= \frac{V^2}{2g} \frac{G}{144}$ in lbs per sq. inch further.

Total pressure upward = weight of particle or projected area x P = volume of particle x density and in case of a spherical particle

$$\frac{d^2\pi}{4} \times P = \frac{d^3\pi}{6} \times K \quad \text{which reduces}$$

to $$\frac{P}{4} = \frac{d\,k}{6} \text{ or } d = \frac{3\,p}{2\,k}$$

but $$P = \frac{V^2}{2g} \frac{G}{144}$$

Hence $$d = \frac{3}{2k} \frac{V^2}{2g} \frac{G}{144} = \frac{V^2 G}{192\,gk} \qquad (1)$$

v is determined by the furnace top dimensions and the amount of blast furnace gas produced per second in cu. ft. at actual temperature and pressure.

v is about equal to 7 feet per second when the gases flow uniform through a furnace top of 17.5 feet diameter at the rate of 1680 cu. ft. per second, when top temperature 420°F and top pressure 42 inches water. This corresponds to 1092 cu. ft. of gas per sec. at standard temperature and pressure and an iron production of 720 tons per day at 1850 lbs. coke practice.

K may be taken about half the weight of cast iron for ores containing 45 to 55% iron, we have then K = .13 lbs. per cubic inch.

for G = .05 and g = 32.2,

We find $$d = \frac{V^2 G}{192gk} = \frac{4\,g \times .05}{192 \times 32.2 \times .13} = .003\text{-inch}$$

d is then the diameter of the heaviest dust particle that will move upward, when v = 7 ft. per second. A cylindrical particle (Fig. 2) would not move under these conditions as its height is several times larger than its diameter; consequently its weight prevents motion under above conditions. A moving object follows always the path of least resistance by turning its smallest section against the wind or gas.

By means of formula (1) we find that the diameter and therefore the size of the particle varies:

(1) Directly with the square of the velocity and with the density of the furnace gases;

(2) Indirectly with the density of the particle and the acceleration of gravity, the latter is practically a constant for different locations.

It is therefore not difficult to explain the reason why occasionally large lumps of coke are thrown out

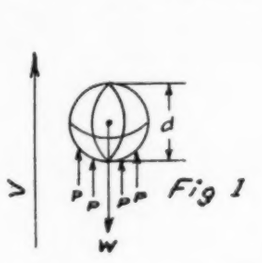


Fig 1

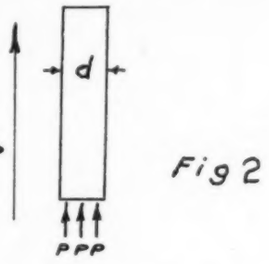


Fig 2

of the furnace during slippage on account of high velocity and density of the gases and low density of the coke.

Experiments made with flue dust show that a considerable percentage passes a 100 mesh screen, which means that there is always a certain amount that will be carried away by the waste gases, for dust particles may be as small as 0.000002 of one inch in diameter, which is considerably less than the 0.003" which was found in previous calculations as the diameter of the maximum size of spherical iron ore particle that could be lifted when gas velocity was only seven feet per second.

Carbon and limestone particles may be larger in proportion with their specific volumes, that is, dust particles having only half the density as compared with an ore particle may have a diameter twice as large and will still be carried away with the waste gases.

2. Height of Free Space Above Stock Level

In previous calculations we found a diameter of 0.003 inch for a spherical dust particle that could be moved upward when the velocity of the gases above the stock level was 7 feet per second. It is evident from Fig. 3 that the dust particle leaves the space between the solid material located near the stock level with a much higher velocity V_1.

Twenty per cent free space (void space) between the solid material of the burden gives the small particle a velocity of V_1 = 35 feet per second.

It takes time and space before the velocity V_1 of the particle is reduced to a velocity V = 7 feet per second in order that the particle may fall back to the stock level. The reduced area of the down comers causes a velocity increase near the entrance. The required height between stock level and center of downcomer becomes then

(2) $$H = \frac{V_1^2 - V^2}{2g} = \frac{1225 - 4g}{64.4} = 18.3 \text{ ft. for 20\% void sp.}$$

and $$H = \frac{784 - 4g}{64.4} = 11.3 \text{ ft. for 25\% void sp.}$$

This illustrates the importance of the HEIGHT (H) above the stock level.

The formula (2) is derived by means of the laws of gravitation and conservation of energy.

AVERAGE PROPERTIES OF DRY FLUE DUST PRODUCED BY BLAST FURNACE OPERATED WITH MESABA ORES

Screening Test and Screen Dimensions				Properties of Spherical Dust Particle Passing the Screen		
Size of Screen	Per Cent Remaining on Screen	Size of Wire of Each Screen Inches	Size of Free Opening in Inches	Maximum Diameter Inch	Relative Weight of Particle in Per Cent	Gas Velocity Required to Lift Particle in Feet Per Second
2 mesh	1.68	.063	.437x.437	.437	50246000	62.3
8 "	1.96	.028	.097x.097	.097	545200	29.4
20 "	4.60	.016	.034x.034	.034	23600	17.4
40 "	18.43	.010	.015x.015	.015	2012	11.5
60 "	35.64	.008	.0087x.0087	.0087	394	8.8
80 "	4.70	.0058	.0067x.0067	.0067	182	7.7
100 "	5.85	.0045	.0055x.0055	.0055	100	7
Balance	27.14%	Passed the 100 mesh screen containing 10000 openings per sq. inches.		Density of particle .13 per cu. in.		
Total	100.00			Density of Bl. Fce gas .05 lbs./cu. ft.		

Chemical composition of the dry flue dust varies from 52-57% iron.

A normal sample shows about: 55% iron or about 79% iron oxide
5 carbon
10 silica
3 alumina
3 lime

and small amounts of magnesia and sulphur.

Weight of flue dust varies from 90 to 100 lbs. per cu. ft.

A free falling body (W) falling from rest through a height (h) acquires a velocity, determined by the relation

Change in Potential Energy = Kinetic Energy

or $Wh = \frac{W}{2g} v^2$ and $v^2 = 2gh$

That gives the height a body will move upward when its velocity changes from v to rest equal to $h = \frac{v^2}{2g}$ and from a velocity v_1 to rest equal to $h_1 = \frac{v1^2}{2g}$, therefore a change of velocity v_1 to v requires a height $H = h_1 - h = \frac{v1^2 - v^2}{2g}$ when moving in vacuum.

A moving flue dust particle is subject to friction losses which tend to reduce H below the theoretical maximum.

3. Why Does One Furnace Produce So Much More Flue Dust Than Another?

The answer to the question is generally agreed upon as being: The more uniform working of one furnace as compared with another. A new furnace works in general more uniform than an older furnace notwithstanding the method of charging the same in both cases. The explanation for this is, that the condition of the lining of a new furnace allows better distribution of burden and products of combustion, which accounts for a more gradual sliding down of the burden. The ratio of ore, limestone and coke present in the burden is determined by its chemical composition and about the same for the same grade of iron. There exist different opinions about how to charge the burden, that is, one party claims best results by charging the furnace continuously and the other favors a more intermittent charging method. The remarkable fact is, that both parties are able to back up their arguments by results,

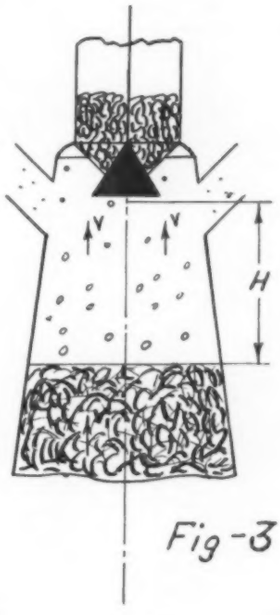


Fig-3

for so far as iron production goes. The flue dust production and coke practice are generally not keeping in step with the iron production.

Form. (1) $d = \frac{v^2 G}{192gk} = \frac{(\text{gas velocity})^2 \times \text{gas density}}{6182 \times \text{density of flue dust}}$

support the argument that the uniform working furnace produces less flue dust for low top velocity is only warranted by uniform flow of gases through the free space above the stock level, which is only possible when the flow throughout the furnace is uniform and brings us to the source of disturbance, that is, the tuyere zone of the furnace.

Uniform combustion at the tuyere zone demands uniform air supply at the tuyeres.

The writer has made many investigations and measurements with a special flow tube, which enabled him to determine beyond doubt the amount of wind passing through each tuyere in cu. ft. per minute and in % of total wind delivered to the furnace and therefore to confirm the importance of uniform flow at the tuyere zone. He always found that irregular wind distribution at the tuyeres was going

parallel with irregular working of the furnace and consequently less iron output combined with higher flue dust production and coke practice.

In fact every furnace operator knows whether the furnace is working right or not by simply looking through the peephole located at the back of each tuyere, but it is quite different when one knows that things are out of step or when he knows how many cubic feet or per cent of total wind is handled by each tuyere.

4. Blast Furnace Control

The desirability of uniform flow of the gases as well as of the burden put us up to the question: How can we maintain the uniform flow and consequent uniform operation of a blast furnace?

The answer to the question is control.

Remarkable results have been obtained in different branches of industry by application of a controlling device. We have at present reliable regulating devices on the market and therefore one of the great obstacles in furnace control has been eliminated. A controlling device is made up of a control valve operated by a regulating device.

As many successful results have been obtained by regulation of the air requirements for combustion and uniform distribution of the combustion zone in boiler and heating furnaces, we have at once a hint which will give similar results when applied in blast furnace practice.

We have, however, a more difficult problem in blast furnace operation as we are dealing with comparative high air pressures and temperatures, besides, we are not allowed to interfere with the continuous operation of the furnace.

A controlling device to be used in blast furnace practice is expected to stand up, not only for days or weeks, but for a whole furnace campaign, that is for a few years. Blast furnace operators have already a large amount of trouble and grieve to contend with, so only then, when we can give them some help without any prospect of more trouble afterwards, we may hope that they are willing to listen to something different from the older way of doing things.

5. Financial and Commercial Considerations

The vital factor when contemplating the application of a new device in a manufacturing plant is not so much the desire of introducing something new, but merely the desire of reducing manufacturing cost. It is therefore that in its last analysis a proposition has to be expressed in dollars and cents.

In the case of flue dust production, it is a known fact that every ton of flue dust produced involves extra expense, no matter whether it is partially recharged as dry flue dust or as sintered flue dust. Considering that the iron ores represent a value of about five dollars per ton as delivered to the blast furnaces. It is conservative to put the value of dry flue dust at least at two dollars per ton. The production of flue dust involves not only a loss of ore but also a loss of lime stone, coke and heat.

A furnace producing 200,000 tons of pig iron per year may produce as much as 40,000 tons of flue dust. A controlling device may reduce this without difficulty to 20,000 tons which would mean a saving of $40,000 per year per furnace.

Considering the tabulation pertaining to the screening test of flue dust and the maximum diameter of spherical particles, we arrive at the conclusion that a uniform velocity of seven feet per second would reduce the production to less than 25% of the present loss, for only the particles passing a 100 mesh screen approach a diameter of .003 inch, which was found to be the maximum for the normal velocity and even a velocity up to 8.8 feet per second would keep the loss below 40%, for according to the tabulation this would include all the dust passing the 60 mesh screen, which is equal to 27.14+5.85+4.70= 37.69% of the total.

Although there are some difficulties connected with blast furnace control, it is not as difficult as it may appear to some people. Space does not permit to give details connected with a blast or blast furnace control. The foregoing discussions indicate however that blast control is closely related to blast furnace control.

Blast furnace control is no more an hallucination, but something that can and will be done in the near future.

Proposed Revision of Constitution of the Association of Iron and Steel Electrical Engineers

Revised Sept. 11, 1918
Revised July 11, 1919
Revised Sept. 20, 1920
Revised Sept. 11, 1922

ARTICLE 1

Name and Object

1. The name of this Association is the "ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS."

2. The OBJECT of this Association shall be the advancement of the application of electricity and other branches of engineering to the iron and steel or allied industries by the co-operation of its members.

3. Among the MEANS to be employed for attaining this end shall be periodical meetings for the presentation of professional papers, the discussion of subjects pertinent to the industry, iron and steel expositions, holding conventions, inspection trips and the publication of an official magazine known as the "IRON AND STEEL ENGINEER," containing papers, discussions and other matters as may seem expedient.

4. While local sections or the National Association may hold single joint meetings with any other Engineering

Society, if in their judgment it is desirable, no permanent alliance of any kind shall be entered into by the Association, or any of its branches, with any Engineering association or other Society. No motion shall be entertained by either the Board of Directors, or Board of Advisors under this constitution which will actually or in effect accomplish such an alliance.

ARTICLE II

Membership

1. The MEMBERSHIP of the Association shall consist of persons actively engaged in or identified with the application of electricity and other branches of engineering, to the iron and steel or allied industries, and firms engaged in the manufacture of iron and steel or allied products.

2. The classes of membership shall be six in number, namely, Firm, Honorary, Life, Active, Associate and Junior.

3. Honorary, Life, Associate and Junior members shall be entitled to all the rights and privileges of the Association except the right to vote and hold office.

4. FIRM MEMBERSHIP shall include those companies engaged in the manufacture of iron and steel.

5. HONORARY MEMBERS shall be persons who have rendered acknowledged eminent service to engineering in the iron and steel or allied industries.

6. LIFE MEMBERS shall be persons who have rendered acknowledged eminent service to the Association of Iron and Steel Electrical Engineers.

7. ACTIVE MEMBERS shall be persons not less than 21 years of age, actively identified with or having a responsible charge of electrical and allied branches of engineering in the Iron and Steel or allied industries.

8. ASSOCIATE MEMBERS shall be persons not less than 21 years of age actively identified with the application of electricity or equipment to the iron and steel or allied industries, (b) persons engaged in the manufacture or sale of material or apparatus used in the iron and steel or allied industries.

9. JUNIOR MEMBERS shall be persons not less than 18 years of age who are students in some recognized institution of learning or those actively engaged in the Iron and Steel Industry, not eligible under any other classification.

ARTICLE III

Admission, Transfer and Expulsion of Members

1. APPLICATION for admission to membership shall be on a form prescribed by the Board of Directors, and shall embody a full record of the general and technical education of the applicant and of his professional career. Forms shall be signed by the applicant and shall give for references the names of at least three members by whom the applicant is personally known and shall be approved by the member of the Board of Directors, who is the representative of the geographical district in which the application is made.

2. In the event of unfavorable replys or failure to receive replies from references, the applicant may be called upon to give further references. Should applicant be not personally known by three members, reference to other Engineers or Engineering Societies of recognized standing may be accepted.

3. Reference to members to whom applicants are personally known may be waived in case of foreign applications, but the applicants shall in that case refer to at least two engineers of recognized standing.

4. ADMISSION to Honorary and Life Membership shall require nomination by unanimous vote of the Board of Directors, and election by vote of not less than three-fourths of Active members present at the annual meeting.

5. ADMISSION of Active, Associate and Junior members shall be by unanimous vote of the Board of Directors after application has been made in due form and approved by the full Membership Committee, and by payment of entrance fee.

6. ACCEPTANCE OF ELECTION to membership must be within six months of date of election.

7. TRANSFER from one grade of membership to another shall be made in accordance with this Constitution by application to the Board of Directors, whose decision by unanimous vote shall be final.

RESIGNATION AND EXPULSION.

8. Notice of resignation from membership shall be reported to the Board of Directors, whereupon if all of the member's dues and other indebtedness to the Association have been paid, the resignation shall be accepted and his name removed from the roll.

9. Expulsion of a member may be considered by the Board of Directors at the request of ten members.

Should there appear sufficient cause, the accused shall be advised of the charges made and shall be given opportunity to make a defense at a meeting of the Board of Directors, of which meeting he shall receive at least twenty days' notice. If satisfactory defense is not made, the accused may, by unanimous vote of the Board of Directors, be expelled from membership.

10. The continued delinquency for six months following the notice from the Secretary of suspension for nonpayment of dues shall be considered equivalent to the resignation of the member and he shall be automatically dropped from the roll of the Association, without action of the Board of Directors, and so notified by the Secretary.

11. TERMINATION of a membership in the Association, for any reason what-so-ever, nullifies all further rights and privileges in the Association and the property thereof.

REINSTATEMENT

12. Reinstatement may, by unanimous vote of the Board of Directors, be made within two years from termination of membership, without payment of entrance fee. Original date of election may be retained by payment of all back dues.

A complete file of the proceedings corresponding with such payment shall be furnished, provided same are available.

ARTICLE IV

Dues

1. Entrance fee for Membership, except Junior, in the Association, shall be Ten ($10.00) Dollars.

2. The annual dues, except for Junior Membership, shall be Ten ($10.00) Dollars. Junior Member dues shall be Three ($3.00) Dollars per year. Honorary, and Life Members are exempt from all payments.

ARTICLE V

Officers

1. The officers of the Association shall consist of a President, First Vice President, Second Vice President, a Secretary and a Treasurer.

2. The President and Vice Presidents and Directors shall serve for one year and shall not be eligible for an immediate election to the same office. The Secretary, and the Treasurer may be successively re-elected from year to year. The Officers for the ensuing year shall be elected at each Annual Meeting and shall hold office for one year beginning the first day of July.

3. A vacancy in the Office of President shall be filled by the First Vice President. A vacancy in the office of the First Vice President shall be filled by the Second Vice President. Any other vacancies shall be provided for by the Board of Directors for the unexpired term. Such succession to office or appointment by the Board of Directors shall not render an officer ineligible for immediate election to the same office at the next annual meeting.

4. No officer shall receive, directly or indirectly, any salary or compensation from the Association, either as such officer or in any other capacity, unless such payment is authorized by vote of a majority of the Board of Directors.

5. No officer shall be interested, directly or indirectly, in any contract relating to the operations conducted by the Association, nor in any contract for furnishing supplies thereto, unless expressly authorized by a unanimous vote of the Board of Directors.

ARTICLE VI

Election of Officers and Directors

1. The Board of Directors shall, before April 1st, furnish the Secretary a list of nominees for offices falling vacant, and for Director at Large.

2. The Secretary shall, not later than April 15th, mail this ballot on official form to all members in good standing.

3. Members not wishing to vote for the nominees whose names are printed on the official ballot, may substitute the names of any eligible members.

4. The voting shall be by secret letter ballot, the voter signing his name on an outside envelope and the ballot enclosed in an inner sealed and unmarked envelope. To be considered, all ballots must reach the Secretary before June 1st. The results of the election shall be announced at the Annual Meeting of the Association.

5. Only Active members (as defined in Article II Par. 7) shall be eligible to hold office.

6. The President shall on the first day of the Annual Meeting appoint three members, not members of the Executive Committee, to constitute a Committee of Tellers. The Secretary shall deliver to the Tellers, unopened, all ballots received by him; marking the outside envelopes received from members not entitled to vote. The Tellers shall open only the envelopes that are not thus marked, and shall proceed in secret to count the votes received. All ballots and unopened envelopes shall be returned to the Secretary, who shall preserve them for one month. The Tellers shall hand a signed report of the results of the vote to the President, who shall read this report at the Annual Meeting, and shall declare, duly elected, the eligible persons receiving the greatest number of votes for the respective offices.

ARTICLE VII

Management

1. The control of the affairs of the association shall be vested in a Board of Directors.

2. The Board of Directors shall be made up of the President, 1st and 2nd Vice Presidents, the Secretary, the Treasurer, the two junior Past Presidents, a Director from each Engineering Section, a Director from each geographical section, and a Director at large, complying with article II, Sec. 7.

3. There shall be a Board of Advisors composed of all Past Presidents, who are active members under the provisions of Article II Sec. 7, or life members elected by the Board of Directors.

4. The detail affairs of the Association shall be handled by a Managing Director.

BOARD OF DIRECTORS

5. The ordinary affairs of the Association shall be under the control of the Board of Directors in accordance with the Constitution and the general provisions of the laws under which the Association is incorporated.

6. The Board of Directors shall control the investment and care of the funds of the Association, shall make appropriations for specific purposes, shall pass upon all applications for admission, shall act upon all questions of expulsion of members, shall appoint all employes and fix their salaries, and in general shall direct the business of the Association either itself or through the Officers, Committees, and Managing Director.

7. The Board of Directors shall adopt by-laws which shall govern its procedure and that of its Officers, Committees and Managing Director. Such by-laws shall be adopted or may be amended by a two-thirds vote of the Board of Directors in person or in writing. The text of a proposed By-Law or Amendment shall be furnished in writing to each member of the Board of Directors at least ten days before the meeting at which a vote of the same is to be taken.

8. The Board of Directors shall appoint a reliable financial institution to act as Trustee for the funds of the Association.

9. The Board of Directors may appoint local Secretaries to represent the Association in various parts of the world and who shall be under the direction of the President and Secretary of the Association.

10. Four members, in person shall constitute a quorum of the Board of Directors.

11. The "Vote of the Board of Directors" shall in all cases be the vote of a majority of the members present or represented by proxy.

THE PRESIDENT

12. The President shall have general supervision of the affairs of the Association under the direction of the Board of Directors. He shall preside at the meetings of the Association and of the Board of Directors, at which he may be present, and shall be ex-officio a member of all committees. The Vice Presidents, in order of official rank, shall preside at meetings of the Association and of the Board of Directors in the absence of the President, and shall discharge his duties in case of a vacancy in the Office. The President, shall appoint the following standing committees: Combustion Committee, consisting of at least six members; Membership, consisting of at least three members; Editing, of three members; Finance, of three members; Safety, of at least six members, and Standardization, of six members. He may also temporarily appoint other committees, as required. The members of the Finance Committee shall all be members of the Board of Directors.

13. The President shall furnish quarterly to the Board of Directors a statement of the receipts and expenditures and the monthly balances, which statement shall be approved by the Treasurer.

THE SECRETARY

14. The Secretary shall himself or through the Managing Director, prepare the business for the meetings of the Board of Directors and record the proceedings thereof. He shall, as instructed by the President, notify the Directors of meetings and of any other activity to which it is their duty to attend. The Secretary shall confer with the Managing Director and co-operate with him to the fullest extent in preparation of material for meetings and reports which must be presented from time to time for consideration of the Officers of the Association.

THE TREASURER

14a. The Treasurer, under the Board of Directors, shall have general supervision over the funds, and accounts of the Association.

ALL COMMITTEES

15. All committees shall be directly responsible to the Board of Directors and shall act under its direction. The Board of Directors may at any time require the President to remove any or all members of the Committees and appoint successors. The term of the members of all standing and temporary committees shall terminate with the appointment of their successors.

THE FINANCE COMMITTEE

17. The Finance Committee under the Board of Directors shall have supervision of the financial affairs of the Association. It shall employ a certified public accountant to audit the accounts annually, and send a written report to the Board of Directors not later than June 1st.

THE EDITING COMMITTEE

18. The Editing Committees shall have supervision of the papers to be presented to the Association at its Conventions, and of the discussion thereon. It may edit all discussions. It may control the force and amount of matter to be printed in the Transactions. It may decide all questions regarding the publication of papers, discussions and communications, and the subject matter thereof, subject to approval of Board of Directors.

THE MEMBERSHIP COMMITTEE

19. The Membership Committee shall issue all application forms for membership, receive and pass upon all signed applications, and report its recommendations to the Board of Directors, which shall in turn act upon each application, after which the Secretary shall notify applicant of result.

TRUSTEE

20. The Trustee shall be a reliable financial institution, selected by the Board of Directors, who shall take care of all the funds of the Association, thereto intrusted. The Trustee shall invest such funds as may be ordered by the Board of Directors and shall pay all bills when approved by the President and Managing Director.

MANAGING DIRECTOR

21. A Managing Director shall be appointed by the Board of Directors to handle the detail business of the Association under the general supervision of Pres. (See Sec. 12,) for a term of years and at a remuneration which shall be agreed upon with the Board of Directors. The Managing Director shall have a seat on the Board of Directors but no vote. The contract with the Managing Director must be signed for the Association by the President and attested by the Secretary at the time of its execution, after being properly executed by the Managing Director.

22. The duties of the Managing Director shall consists of managing the work of the Association, the preparation of the business for all meetings of the National Association, and record of the proceedings thereof. He shall personally certify to the accuracy of bills and vouchers on which money is to be paid, before they are submitted to the President for approval. Under the general supervision of the Treasurer, he shall be responsible for keeping a record of the financial affairs of the Association. He shall prepare an annual balance sheet for consideration of the Board of Directors as soon as possible after the completion of the Association fiscal year, publish the Association's periodical, superintend and manage Iron & Steel Exposition's, and arrange for technical sessions, thereat under the general supervision of the Board of Directors.

23. The Managing Director shall be responsible for the proper conduct of the Association's correspondence and shall be furnished by all committee Chairmen, copies of such correspondence as they may handle directly for file in the Association's records.

24. The Managing Director will have charge of the business office of the Association and maintain such an office force as may in his judgment be required to handle the affairs of the Association, subject to the approval of the Board.

25. The Managing Director will receive all moneys due and turn them over promptly, for credit to the Association's accounts, to the Trustee. He shall report all such deposits to the President of the Association who will acknowledge same.

25a. The Managing Director shall furnish a Bond satisfactory to the Board of Directors.

THE BOARD OF ADVISORS

26. The Board of Advisers shall be made up of all Past Presidents, shall pass on all matters referred to them by the Board of Directors, but no member of the Board of Directors, sitting on the Board of Advisors, shall have a vote on the Board of Advisors. Meetings shall be at the call of the Chairman of the Board of Advisors.

27. The first Chairman of the Board shall be the senior living Past President, in point of service as President of the Association. He shall hold office for one year and then be succeeded by the next in rank of seniority; the succession to follow the same course from year to year.

28. The Board of Advisors may not of themselves originate any business or legislation, but can only act when called upon by the Board of Directors.

28a. Any extraordinary affairs of the Association; such as: matters of policy; changes in the purpose of the association; expenditure of invested funds; revision of the Constitution; and any business which the Board of Directors deem advisable, shall be referred to the Board of Advisors by the Board of Directors.

29. Any question which is considered of sufficient weight by a quorum of the Board of Directors at a stated meeting, may be submitted to the Board of Advisors, for their opinion.

30. In submitting a question to the Board of Advisors, a written statement for each member, covering the matter involved with the reasons for or against, shall be sent under registered mail to the Chairman of the Board of Advisors. The statements shall be inclosed in addressed and stamped envelopes, unsealed, so that the chairman may insert any statement or suggestion regarding the question which he may deem advisable. After reviewing the subject each member of the Board of Advisors shall send his written and signed opinion to the Chairman who shall hand the decision, as represented by the majority of the Board of Advisors to the President of the Association to report to the Board of Directors at its next meeting.

Should the Board of Advisors fail to render opinion on any question referred to them by the Board of Directors within 60 days from date of such request the matter will automatically return to the Board of Directors for decision.

31. The Chairman of the Board of Advisors shall at any time upon request by the Board of Directors through the President within 30 days after rendering an opinion, submit for the inspection of the board, all papers, including the individual opinions of its members covering the question.

32. Should the Board of Advisors submit a negative recommendation on a proposal to amend the Constitution, such recommendation shall in affect lay the proposal on the table for a year.

A negative recommendation on any other question submitted to the Board of Advisors unless concurred in by the Board of Directors shall be submitted to the membership for decision at the next Annual Meeting.

ARTICLE VIII

Meetings

1. An Annual Meeting of the Board of Directors shall be held prior to the Annual Meeting of the Association. All committees shall make complete reports in writing to the President for presentation at this meeting which shall be read by Secretary. The President shall present a report of the proceedings of the Association for the past fiscal year.

The report shall be certified by the President, Secretary and Treasurer. The report shall show the entire amount of real and personal property owned, the nature of the property acquired; the amount applied, appropriated and expended; the names of all those admitted to membership during the fiscal year, and the names of transfers, resignations and members expelled for non-payment of dues or other causes. This report shall be filed with the records of the Association.

2. There shall also be held an Annual Meeting of the Association in June for the presentation and discussion of professional papers, to conduct an Iron and Steel Exposition, and for the transaction of such other business as may be brought before it. The time and place of such meeting shall be fixed by the Board of Directors. An abstract of the yearly report of the Board of Directors, all committees and Managing Director, as submitted at the Annual Meetings of the Board of Directors, shall be read at this meeting by the Secretary and entered in the minutes of the proceeedings of the Annual Meeting.

3. Other Meetings of the Association may be held at such times and places as the Board of Directors shall select. Notice of all Meetings shall be sent to all members at least fourteen days in advance.

ARTICLE IX

General

1. A quorum of the Association shall consist of 10 per cent of the total number of Active Members in good standing, either present or represented by proxy.

2. Every member entitled to a vote at any meeting may so vote by proxy. Every proxy shall be executed in duplicate in writing by the member himself, or by his duly authorized attorney, and one copy thereof shall be filed with the Secretary before the date on which it is to be voted. No proxy shall be valid after the expiration of eleven (11) months from the date of its execution, unless the member executing it shall have specified therein the length of time it is to continue in force, which shall be for some limited period.

3. The fiscal year of the Association shall begin July 1.

ARTICLE X

Amendments

1. Proposals to amend the Constitution shall be made in writing to the Board of Directors, signed by not less than ten members in good standing, or by resolution of Board of Directors. The revision as decided upon by the Board of Directors shall then be referred to the Board of Advisors not later than January 15th for their approval. After being received by the President, from the chairman of the Board of Advisors, it shall if approved be placed in the hands of the Secretary not later than April 15th. He shall send copies of it to all Active Members in good standing not later than May 15th.

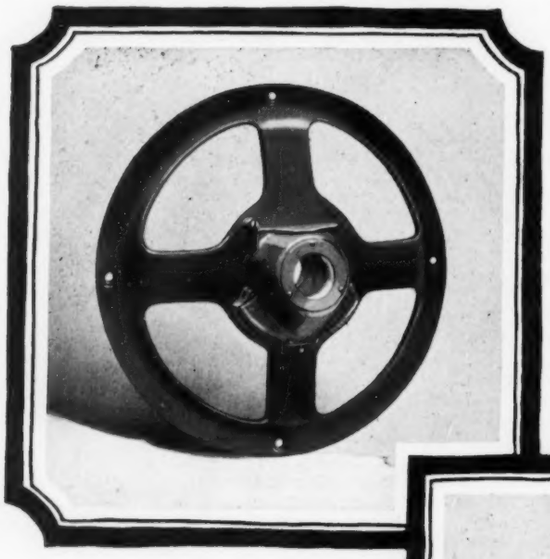
2. The Secretary's affidavit of having mailed such copies shall be presumptive evidence of notice having been given.

3. Ballots on amendments shall be sent to the Secretary in sealed envelopes and counted at the Annual Meeting of the Association by a Committee of Tellers.

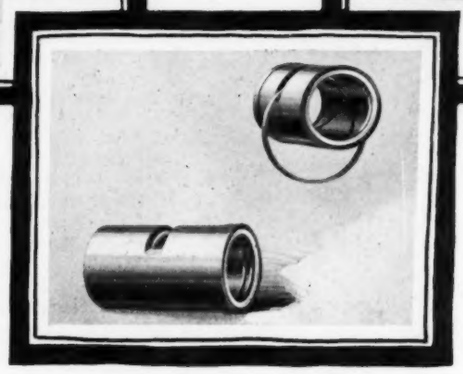
4. If two-thirds of all the members voting declare in favor of the amendment, same shall become a part of this Constitution and become effective the beginning of the next succeeding fiscal year.

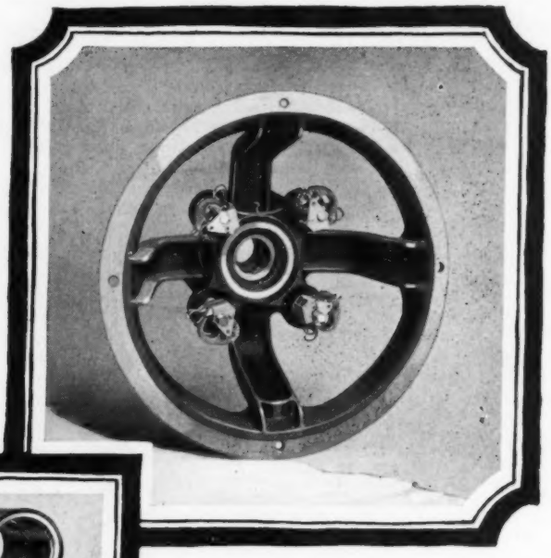
5. No amendment to this Constitution shall abbreviate the term of any Officer elected prior to the adoption of the Amendment.

The "inside" story of Type T Reliance Motors No. 3



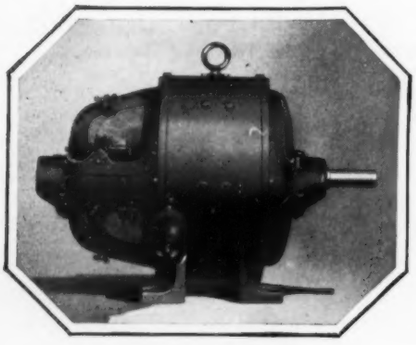
Large oil overflows are cast into the bracket. They have spring covers. There are no external parts to interfere with slings. Any sediment from the oil drops into the pocket under the oil well so cannot interfere with operation of the ring.





You can readily inspect the operation of the oil ring. A steel clip over the oil ring prevents the ring from getting out of place. The heavy oil hole covers are self closing of their own weight.

What do we mean—"heavy duty"?



Type T Reliance Motor with semi-enclosing covers. Motors can also be supplied fully enclosed dust tight or water tight and fully enclosed ventilated.

These bearing brackets partly answer. They are typical of Type T motor construction throughout. See the deep channel-shaped sections in the arms, the deep outside ring and the webs between arms and rings. The extra strength shown here is one of the things that put Type T Motors beyond the ordinary into the heavy-duty class.

All engineers who co-operated with us in the design of these motors impressed upon us the need for liberal bearings and we were careful to follow their advice. Bearings are cast-iron shells babbitted with a high tin content babbitt which has proved that it will stand up under hard service. Solid bearings for both ends of the motor are interchangeable.

Complete details are given in our Bulletin 200

RELIANCE ELECTRIC & ENGINEERING CO.
1080 Ivanhoe Road, Cleveland, O.

Branches: Boston, New York, Buffalo, Philadelphia, Birmingham, Pittsburgh, Cincinnati, Detroit, Chicago

We Build Both D.C. and A.C. Motors.

Type T Heavy Duty
RELIANCE MOTORS
Direct Current